THE

SURVEYOR, ENGINEER, AND ARCHITECT:

FOR THE YEAR

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PREFACE.

The year one thousand eight hundred and forty-two has been distinguished by very little of that public enthusiasm in favour of constructive enterprize for which several of its predecessors have been so remarkable. The fever of railway speculation had long since reached its height; vast sums of money had been wantonly and wickedly squandered in these works, while, after all the lavish expenditure by which they have been accompanied, they utterly dwindle into insignificance compared with corresponding works, which have been executed on the other side of the Atlantic, for a mere fraction of their cost in Britain. At a time when the question of a remunerative return was yet in abeyance, when the partial completion of the principal lines was not yet sufficiently advanced to solve the great problem so deeply affecting the interests of many thousand shareholders in these great works, the strong arm of legislative authority interfered so effectually with the preliminary measures for obtaining Acts of Parliament, that the spirit of railway speculation was at once laid prostrate; and from the blow thus suddenly, and, we are fain to believe, innocently inflicted, the system has never yet revived. We shall be understood here as referring to that part of the standing orders which requires that £10 per cent. of the capital of the company shall be actually raised and deposited in the hands of a banker, before an act of incorporation can be obtained. A strange and striking contrast did the committee rooms of the Houses of Parliament present this session to those thronged and crowded apartments in which the partisans of the great railways and their opponents so pertinaciously contended in former sessions. It was, indeed, a chilling contrast which the lists of the committees exhibited when, instead of such high sounding names as London and Birmingham, Grand Junction, Great Western, South Eastern, London and Brighton, and a host of others, all that the visitor saw were the names of such insignificant projects as the Yarmouth and Norwich, the Warwick and Leamington, and one or two others of no greater note. Such was the state of railway legislation during the past session, and scarcely could any other have been anticipated had all the disadvantages with which the unfortunate system has had to contend been fairly weighed by wise and dispassionate judges. What these disadvantages are cannot be enumerated in this place; but we have much to say upon the subject, and we shall take care on other occasions, without fear, favour or prejudice, to say in good plain English that which the circumstances in question deserve.

During all the last winter the public prints have teemed with frightful accidents, arising from slips in cuttings, subsidence of embankments, and roofs and sides of tunnels falling in:—so much for the credit of the engineers entrusted with their construction.

Again, with respect to their financial affairs, almost every line in the kingdom which is not paying an ordinary rate of interest—and we regret to say that too many are in this predicament—presents the unnatural spectacle of a boisterous and ravenous proprietary at war with their directors and all the other officers of their concern, and at every successive meeting wildly howling for committees of inquiry, and savagely abusing every part of the management by which their concern is conducted. It is impossible that such a state of things can last, for it is alike injurious to the companies themselves, and dangerous to the public, because every railway company is in itself a petty, arbitrary government, almost irresponsible, and the public safety is with a frightful temerity on the part of the state entrusted to the mercy of their self-interested arrangements.

We are persuaded, however, that the whole system of monstrous mismanagement which the railways exhibit, instead of retarding their extension, will rather hasten the full development of the system, inasmuch as it will make legislative interference on an extensive scale more immediately imperative than would otherwise be probable. We look with confidence to the measures of a wise and enlightened government for much greater encouragement than has hitherto been given to the prosecution of railway enterprize, and we shall be mistaken if the path, to a considerable extent, be not prepared during the very next session of Parliament.

Steam navigation has made great advances during the present year. Among the most considerable events have been the employment of iron for building the largest class of steamers, and the application of the screw propeller in place of the paddle-wheels.

Although few great works of architecture have been completed, several have been brought to a state of considerable forwardness. The New Houses of Parliament, the New Royal Exchange, the Nelson Column, and several other important works, are making very satisfactory progress.

Several questions of great practical and scientific interest have been agitated, but without establishing many results that can be safely depended on. The employment of electro-magnetism as a moving power has not yet received a practical application. The crystallization of iron has been extensively discussed both amongst our own *savans* and in the French Academy of Sciences, but the subject is still involved in considerable mystery. The galvanization of iron and other expedients to prevent rust have been the subject of numerous experiments, but hitherto no very satisfactory result has been established.

The pneumatic railway has made a step in public estimation, and so fully persuaded are the Directors of the Dublin and Kingstown Railway of the practicability of working without the aid of steam, that they are now employed in constructing, on the pneumatic principle, the extension of their line from Kingstown to Dalkey.

Amongst the few engineering works at present in progress in this country may be mentioned the Newcastle and Darlington Junction Railway, the Manchester and Leeds

Extension Railway, the South Eastern Railway, nearly completed, and the Sheffield and Manchester. An embankment is being constructed across the estuary of the Nene. Several small harbours in the north have been improved, and one of the docks at Southampton was opened to the public in August last.

We deeply regret to observe a great diminution of profitable occupation for that highly respectable class of surveyors who have hitherto found employment in the measurement of land, and in making surveys for engineering purposes. The Government is principally to blame for a series of most unwarrantable injuries inflicted on this class, and for a systematic accumulation of aggressions upon their standing and respectability, to which there appears no prospect of an end till every particle of professional spirit shall be banished from the English surveyor, and he is reduced to a level, very little, if any, superior to that of his own labourer.

The Land-surveyor must, for the future, extend the field of his occupations beyond the common-place drudgery of merely measuring land; in particular we recommend geology and agricultural engineering to his especial attention. His intimate connexion with landed property and with agriculture affords admirable opportunies for the cultivation of these practical pursuits. William Smith, the father of English geology, was a land-surveyor; he it is who first pointed out the succession of strata, and reduced to a system of order and regularity the whole system of geological formations. The extensive observations which enabled him to achieve so great a work were principally made during the practice of his profession in the open country, and his example affords an encouraging prospect to all those whose ordinary pursuits are similar to those which were professed by this distinguished man. The Surveyor, driven in a great measure from the honourable practice of his profession in his own country, must also direct his energies to the new colonies which are springing up in the South Sea, and in other parts of the world, and where, according to every prospect, a fine field is open for the labours of those who are capable of aiding in the first measures of improvement and cultivation.

The Civil Engineer, too, although he belongs to a body of considerably more influence and one possessing more political connexion than the Surveyor, has not been exempt from the mischievous effects of certain government practices which the present opportunity does not afford us sufficient space to enter upon. It is a consolation, however, to reflect that the engineers as a body possess the power of asserting their own dignity and superiority whenever the petty grievances under which they labour assume sufficient importance to compel a firm and sincere union amongst the disjointed members of the body. Respect for themselves, and a contempt for the host of interlopers, who for some time have been forced into works belonging strictly and of right to the Civil Engineer, inspire at present only a dignified silence, and fail to call forth even the slightest expression of annoyance or dissatisfaction. This, however, is no proof either of weakness or submission, as time will sufficiently prove.

The classes of civil engineering and architecture in the various colleges in which professorships have been established are all numerously attended. The rivalry of the metropolitan colleges is productive of public benefit; and since the recent very judicious appointments of à separate professor of engineering, and one for architecture, at the London University, there appears to be a very obvious vacancy for a professor of civil engineering in the rival institution of King's College.

Upon the whole, we think the prospects of the three professions are decidedly better than at this time last year. The spirit of public improvement is not so entirely sluggish; the hands of Government are strengthened by a large accession of revenue; railway shares are somewhat advancing in price, and the demand for English engineers and contractors on the continent is daily becoming more extensive.

THE SURVEYOR, ENGINEER, AND ARCHITECT;

OR,

LONDON MONTHLY JOURNAL OF THE PHYSICAL AND PRACTICAL SCIENCES

IN ALL THEIR DEPARTMENTS.

BY A COMMITTEE OF PRACTICAL SURVEYORS, ENGINEERS, AND ARCHITECTS, OF MUCH EXPERIENCE AND IN ACTIVE EMPLOYMENT.

ROBERT MUDIE, LITERARY CONDUCTOR.

ENGINEERING HONOURS.—ALEXANDER NIMMO.

TO THE EDITOR.

YOUR very excellent and valuable Journal has on many occasions contained attractive and highly interesting papers regarding the science of engineering.

It has been mentioned, that an application has lately been made to the ———— for a subscription to defray the expenses of either painting a picture, or engraving a portrait, of ————, whose name, it may be observed, is not connected with any great or remarkable engineering work, either in this country or any other; neither is it to be found among the records of invention and discovery; nor is the domain of science under the least obligation to him for its extension in any one of its numerous and useful branches.

On what ground, then, has such a subscription been called for? for it does not appear that any such thing has ever been done for Mr. Brindley, Mr. Smeaton, Mr. Rennie, &c. It may also be observed, that the remains of the late Alexander Nimmo, a man of distinguished talent, and whose acquirements and magnificent mind few were capable of fully appreciating, lie in one of the Dublin churchyards, without a stone to record his name, and mark the silent spot where his ashes lie entombed. There would have been more high-minded and noble feeling shown by ————, and those connected with ————, many of whom were under the highest obligations to that great man, and to his friend and patron, Thomas Telford, had they honoured the place of his remains with a plain granite tombstone, carrying upon it, deeply lettered, some such simple inscription as the following:—

THE ENGINEERS OF GREAT BRITAIN

TO THE MEMORY OF

ALEXANDER NIMMO.

The name of Alexander Nimmo is to be found appended to scientific papers of the highest order connected with civil engineering. The article which was written by him in the Edinburgh Encyclopædia on "Bridge Building," is the ablest and best to be found in the English language; and his paper on "Geology applied to Navigation," printed in the Transactions of the Royal Irish Academy, is original and interesting. It immediately follows the paper on the parallax of the fixed stars, by the late Dr. Brinkley; and although the question regarding the parallax of the fixed stars has divided the astronomers of Europe, the records of science will associate the name of Brinkley with the most delicate astronomical observations which have been made in modern times.

Mr. Nimmo's general chart of the coasts of Ireland and St. George's Channel, exhibiting the sea and harbour lights, drawn chiefly from original surveys, with sailing directions, is one of the most accurate works of the kind published.

His fishery charts of the harbours of Strangford, Dundrum Bay, Carlingford Bay, Howth to Balbriggan, Dublin Bay, Sligo Bay, Killala Bay, Clew Bay, Costello Bay, Roundtown Bay, Galway Bay, and Valentia Harbour, are from original surveys, and have been neatly and beautifully engraved in London, principally by the late Mr. Neale; but the charts of Carlingford, Sligo Bay, and Galway Bay, were engraved by the late Mr. Wilson Lowrey, a gentleman of great and distinguished talent, not only as an engraver, but also as a geologist, and who first applied the diamond to cutting lines on copper with equal pressure. His instrument for the drawing of parallel lines remains a monument of his genius. He was a Fellow of the Royal Society of London, and had a high veneration and friendship for the late Alexander Nimmo.

Mr. Nimmo, while engineer to the Irish Board of Fisheries, designed and erected a considerable number of small piers around the shores of Ireland, to protect the fishing craft. Small plans of these piers have been engraved by the House of Commons, and are to be found among the parliamentary records. They were undertaken and commenced upon a limited scale, and the means grante was in several instances very inadequate to erect them in a permanent and substantial manner.

Mr. Nimmo designed and erected the pier of Dunmore, in the south of Ireland; and Kinlough, in the north of that country. He designed the Dublin and Kingston Railway. He also surveyed a railway from Waterford to Limerick, and wrote a very able report upon it. Many roads were designed, and executed by him, in the counties of Cork, Kerry, Galway, Mayo, Sligo, Roscommon, &c. He reported and gave designs for improving the ports of Drogheda and Newry, the harbours of Courtown and Sligo. He designed a dock, and erected the Sleat Pier at Galway. He also proposed a canal between the sea and Lough Corrib, at Galway. He repaired the old timber bridge over the Shannon at Portumna. He designed and erected the timber bridge over the Blackwater, at Youghal—a work of very considerable magnitude. He gave a small design and report for a ship canal, to connect the docks and port of Dublin with the harbour of Kingston.

His reports, maps, and sections for the drainage and improvement of the bogs in the counties of Cork, Kerry, and Galway, are the most important and useful documents which have ever been written regarding the national improvement of a part of the waste lands in Ireland. They have been engraved and printed by the House of Commons, and are to be found among the reports of the engineers employed by the parliamentary commissioners, appointed to inquire into the practicability of draining and improving the bogs in Ireland.

The Wellesley Bridge, erected over the river Shannon, at Limerick, is one of the most unique and beautiful works of the kind yet executed in Ireland.

Mr. Nimmo's Engineering Reports have instructed and delighted every person who has been so fortunate as to read them. He was

a gifted master of language, full of invention and resource, nor was there hardly any department of knowledge to which he was a stranger. His faculties were of such a high and inquiring order, and his power of application so intense, that he was enabled to comprehend with great rapidity the most complex subjects in science and legislation. He was not only a great engineer, but an accomplished philosopher and a great statesman. His able and long continued advocacy of a poor law to ameliorate the misery and the distress of the poor population of Ireland, alone merits to his memory a full-sized statue in bronze. Those who were acquainted with Mr. Nimmo, cannot but remember with delight the vast powers of his memory, the extraordinary depth and varied extent of his knowledge, which enlightened all those who had the pleasure of enjoying his company. He was not only the best educated and the most scientific, but he was incomparably the best informed engineer that Great Britain has yet produced.

When the cultivators of engineering and engineering science shall have paid the tribute so justly due to the memory of the departed, by marking the spot where the remains of Nimmo rest by a plain tombstone, the next step should be for them to collect and print all his reports, to which should be appended a memoir of him. What a mass of useful and valuable engineering knowledge would such a work present; it would be highly deserving of being subscribed for among the profession. In such a work there would be found much to study, and to instruct, and delight, those imbued with a taste for engineering. A work of this kind would be well worthy of any expenditure of money it might cost, and would be much more valuable to engineers than an image of ———.

Two or three hundred pounds for a picture or engraving of ——. Why, if such a thing be wanted, he is quite able to defray the expense without trespassing upon the bounty or the generosity of others; but the money so expended might be much more usefully applied to many other purposes; for instance, as a donation to a library, open to all. Two or three hundred pounds worth of engineering books, designs, &c., would do much more good than a portrait or an engraved picture.

Even supposing the picture of ——— engraved or painted, it may again be asked, what works of engineering are connected with his name? or what department of science is under any obligation to him to warrant such an expenditure? or in looking at his picture, would any noble ideas arise to the beholder connected with the improvement and extension of the engineering arts or sciences? On the other hand, noble thoughts would arise in looking at the pictures of Brindley, Watt, Rennie, Smeaton, &c., connected with their inventions and their works, which are extremely well suited to call into active exertion the minds of all those devoted to the study of engineering, or to the contemplation of the labours of the engineer.

In alluding to this subject it may be observed, that there is not the least intention to undervalue ———, either in the creation or erection of any engineering works which he may have done, or in the repairing and patching up of the old works of other engineers, or in those more splendid efforts of genius which may be ascribed to him for original and useful inventions: there is a perfect willingness to allow him to the fullest extent all the high and merited distinction which it can be shown he is entitled to in the fields of engineering science and of the arts, but we cannot see any reason at present for expending money on a picture of him; there appears at the least to be great vanity in it and little sense, either in those who advocate such a measure, or in him who permits it to be done; and we have yet to learn that he has executed any engineering work which is worthy to be named, or invented anything connected with either science or mechanics, to distinguish him, or which could extend fame to his name. Perhaps it has been thought that a painted picture or an engraved portrait, lettered with the pompous title of ———, might draw attention, and do some little thing in that way; and that the state might extend to him a similar *title* to that which has been so justly and so honourably bestowed upon Rennie and Brunel, for the genius and invention displayed in the execution of their engineering works.

Far from presuming to think that either an engraved portrait, a painted picture, or even a title emanating from the government of a state, can ever add anything to the glory which is due to the achievements of men of genius, no title which could have been conferred by the greatest monarch on earth could have added anything to the dignity and splendour with which invention has encircled the name of James Watt; no title, however high or nobly conferred, could have extended the fame and the admiration of James Watt into all those distant regions of land and water which cover this globe, or could have conferred upon his name that lasting celebrity which it is destined to carry into the most remote limits of existing time.

Had it been a subscription for painting a picture or erecting a statue in honour of the genius of George Stephenson of Newcastle, the author of those splendid modern inventions which are carrying civilization through so many of the most interesting and highly cultivated states of both the old and the new continents, it would only have been paying a just tribute to the merit of one of the most distinguished practical men of the day, and whose name is now inseparably associated with the most brilliant and most successful achievements in engineering which have ever taken place in any age. It may again be observed, that no title which a great and a free people, or even those which emperors and kings the most powerful could bestow upon him, can ever equal the fame and the imperishable renown which railway and locomotive engineering are conferring upon his name; and it ought never to be forgotten, that when the Manchester and Liverpool Railway was in progress of execution, it was unfavourably reported upon by the most influential government engineer of that period. But the genius of Stephenson rose triumphant, not only in the execution of the railway, but also in the application of the locomotive engine; and the success was justly hailed throughout Europe, not only as the greatest wonder of the age, but as an achievement which had extended a lustre even on the genius of man.

B. W.

NOTES BY THE CONDUCTOR.

Agreeing in the main with the strictures made by our very intelligent correspondent, and as fully convinced as he is that images and honours—that is, words intended to confer honour—are generally bestowed upon those who need them the most because they deserve them the least, we have taken the liberty of substituting a plain rule for the stars in his MS., because the said stars might have led to a personal application of what is really general, admitting of countless applications, not in the engineering profession only, but in all professions which are understood as being calculated to raise those who belong to them above the mere clods of

the valley. A molten or a graven image may be a very proper, and we doubt not an extremely welcome donation to a man who has no memorial in his own works, of contrivance, of execution, or of writing; but in the case of a man who has one or all of these, the supplement of the statue, the painting, or the engraved effigy, is very insignificant, hidden by the splendour of the real achievements as a rushlight is by the radiance of the mid-day sun; and the most that can be said about it may be an act of justice, a confession of superior merit, made for the party represented by those who provide the representation.

In the case of an eminent engineer, or of any other eminent man, we should be glad to know how these things can do him honour; and of the illustrious names mentioned by our correspondent, together with many hundreds more that could be added, the renown would not be increased one iota, although an apartment double the size of Westminster Hall were hung round with the portraits and crowded with the statues of one individual. As for the monument and the memorial of Watt, there is not a sea or a navigable river upon the face of the globe in which it may not be observed working daily for the good of mankind; and though all the illustrious dead are not thus conspicuous in the direct and immediate results of their genius, each and all of them contribute to the grand volume of knowledge, and to the application of that knowledge to the well-being and improvement of the human race: they are the grand pillars of civilization and enjoyment, and their foundations are so deeply laid, and themselves so endowed with strength and durability, that the fabric which they support cannot be shaken by all the efforts of ignorance and oppression, let them conspire and contrive together as they may.

If a picture or a statue, let the likeness be ever so correct and striking, is to be a monumental honour to any party, it is to the painter or the sculptor by whom it is executed; few, even of his own time, in proportion to those who are benefited by the talents of a great man, are the parties to whom his face or his figure is personally known; and hence, after the lapse of a few years, the tenement of clay is mouldered in the dust, its lineaments are forgotten, and all that remains of the great man is the emanation of mind, partaking of the mind's immortality, and incapable of receiving or imparting a likeness from or to colours, or marble, or bronze. We used to admire the monument of Hume in the Calton burying ground of Edinburgh; it was a cylindrical lump of masonry, something in the form of a great tub, and inscribed

"DAVID HUME,"

without any eulogy or sepulchral addenda, true or false; and, without the aid of the satirist, the latter always suggests itself at the sight of an elaborate monument or a flowery epitaph.

One of the finest and most appropriate monuments that we ever met with in England, is in the south aisle of the chancel of Romsey Church in Hampshire. It is a rude flat stone, level with the rest of the pavement, and there are cut into it in long letters these simple words:—

"HERE LAYES SIR WILLIAM PETTY."

There is not one word said about who Sir William Petty was, or what he deserved or acquired: these are supposed to be well known to every person having the least claim to intelligence, and the monument simply marks the spot where his bones are laid.

Between the characters of Sir William Petty and Alexander Nimmo there are a good many points of resemblance, though there are also striking differences; and therefore a certain similarity of monument, such as that suggested by our correspondent, would be very appropriate.

Sir William Petty was the son of a tradesman in Romsey, and possessed a most extensive and versatile genius. He was scientific, mechanical, and political, and did a great deal to throw light upon the subject of Ireland, which was then scarcely as well known as Australia is now; but with all his talents Sir William Petty was, to a very considerable extent, a fortune-hunter, turning everything to pecuniary account, amassing a fortune almost unprecedented in those days, and dying in ease and affluence in or near his native town.

"ALEXANDER NIMMO,"

was possessed of a mind perhaps more comprehensive and more versatile than Sir William, and though his long and most laborious professional engagements must have placed large sums of money in his hands, his attention was much more directed to science and its important applications, and to improving the condition and increasing the comforts of mankind generally, than to anything connected with his own aggrandizement. Satisfied with the high distinctions which his Maker had conferred upon him, he disregarded the world and its possessions, and, we have heard, allowed great part of the earnings of his most scientific and valuable industry to be squandered by those who could do him no honour.

These, however, are personal matters, into the discussion of which we have no desire to enter; our wish is to draw up a short memoir of a man with whom we were intimately acquainted, and, like all who enjoyed that pleasure, could not help admiring as far as the noblest character that man possesses can be admired; but we find that the details, dates, and other little matters which give some consistency to a memoir, are not within the scope of our present knowledge, neither do we know where they are to be found. A connected and luminous memoir of him ought to exist; but the materials which are to be worked into it, and the talent necessary for working those materials into a proper fabric, are among the desiderata of biography.

Mr. Nimmo was born, some time about the year 1780, in Kirkcaldy in Fifeshire, where his father was a watch-maker and ironmonger, not conspicuous for anything that could be considered as inventive or brilliant, but a man of shrewd good sense and undoubted integrity. In his very early years young Nimmo shewed great versatility of mind as well as activity of body, but, at the same time, there was something very peculiar in his manner. He was inventive, a quality which he never altogether lost, and he appeared to be astonished that other boys should find difficulties in matters which he understood at first sight, and apparently without any effort. His progress at school was rapid, but it did not altogether occupy his mind, and thus he had time to see and examine, and talent to understand, all that came within the scope of his notice. We do not believe that what is called original talent is any thing else than the result of careful observation and sound thinking; but with him these began so early, and appeared to originate so entirely with himself, that they got the name, and while yet quite a boy, Mr. Nimmo was regarded as a genius, though a peculiar and eccentric one.

At a very early age—somewhere about that of thirteen—he was sent to the university, where his progress was equally rapid and his conduct just as peculiar. He attended carefully to those classes which the routine of the establishment demanded, but along with this he observed, and formed his opinion upon, all subjects to which

he had access, either by directly examining the subjects themselves, or from what he found in books; which last, however, he read as a critic, and not as a mere collector of scraps of other men's writing. Though brought up in strict Presbyterianism, and at the same time rigidly moral in his character and conduct, he showed no disposition towards the ministry, which was then, and probably is still, the greatest ambition of clever boys among that class of Scotchmen in which he originated. Mathematics and natural philosophy were his favourite studies, and there is no doubt that of chemistry would have been an equal favourite, if there had then been a chemical professor in the college which he attended, or even a supply of chemical works and apparatus.

After the time devoted to the philosophical course in his *Alma Mater* had expired, he went to Edinburgh, in order to increase his knowledge, and also to earn his own living, in part at least, by teaching to others those sciences and subjects with which he was already acquainted. While there he attracted the notice of Dr. John Robison, and also of Professor Playfair, especially the latter, who, among his other splendid qualities, was remarkable for his tact in finding out young men of sterling talent, and encouraging them in the course of knowledge, both by his public lectures and his private advice. Mr. Nimmo was indeed one of those, of whom there was always a number, who were waiting in Edinburgh until Playfair should find situations in which they were likely to be useful both to the public and themselves.

While partly occupied in giving instruction on various branches of science, the number of which increased with his own knowledge, Mr. Nimmo found leisure to attend to chemistry, mineralogy, and other branches of the philosophy of nature, of which he previously had little acquaintance. Not only this; for he wrote a short treatise on a new subject, which, though of little or no practical utility, yet displayed no small degree of ingenuity and geometrical acuteness. This was a treatise on "du-angles," or plans bounded by two similar segments, and having two angles at the points where those segments meet and intersect each other. In as far as figures with two angles can be compared with figures having three, and circular segments can be compared with straight lines, propositions bearing a considerable degree of similarity to those respecting triangles in "Euclid's Elements" were compared with each other; and as they were comparable with these, through the medium of the circle, they were managed with little difficulty. Professor Playfair could not help admiring the ingenuity with which this perfectly useless system of figures was managed; but while he gave the inventor every credit in this respect, he was at no small pains in explaining to him that all the mathematical sciences are intended to be useful; and that, therefore, and in order that talent, calculated to be of no small value to the world, should not be thrown away upon subjects which admitted of no application, the instructor enjoined the pupil that, when any thing new struck his fancy, the first subject for inquiry was the usefulness of its application, and if it appeared to have no such application, it ought to be abandoned as a mere waste of mental energy.

About that time the opposition between the Wernerian and plutonic geologists was making no small stir in the world, in consequence of the clear and obvious truth of what was advanced by Dr. Hutton, and the storm which it raised among the disciples of the Freyburg professor. Notwithstanding the modesty with which the plutonic or Huttonian theory was brought forward by its author, and the little disposition there was on the part of Dr. Hutton to fight, even in the cause of truth, those who thought with him, had to put up with their share of no very manly or measured abuse. Some of the most influential and wealthy, but least informed, in the train of Werner, saw, or fancied they saw, in the final stage of the Huttonian theory, opinions and statements which they could convert into charges of infidelity, and these they brought forward against Dr. Hutton, and all who held similar opinions; and in this they made serious attacks upon the religion of the Doctor, and other persons almost equally talented; among the rest, Professor Playfair. This led to the production of "Professor Playfair's Illustrations of the Huttonian Theory," one of the most pleasant books to read, and the doctrine of which was adopted by every disciple, especially by Nimmo, who saw that the theory must one day be triumphant, and he carried the book with him, as the greatest honour that he could bestow upon it or his friend its author. The comparatively new theory was exactly a subject to attract the attention and exercise the talent of one with so restless and comprehensive a mind as Mr. Nimmo, and accordingly, he from that day became a geologist, and never in the course of his future inquiries and discoveries failed to pay the adequate attention, and award the fair degree of merit, to the geological part of the subjects.

While thus occupied, a situation offered itself; and though it was beneath the talents of such a man as Nimmo, he became a candidate for it, and succeeded, as a matter of course, through the recommendation of Professor Playfair. This situation was that of mathematical teacher in the academy of the little town of Fortrose, often styled the Canonry of Ross; and after some rather ludicrous exhibitions on the journey, owing to the closeness with which he was observing nature, Mr. Nimmo arrived at the place, and entered on the duty of his office. The patrons and managers of this humble seminary were highly gratified by the thought of having such a man in their institution; and as the majority of them, we believe, were freeholders in the county, and men of refined taste and extensive observation, Mr. Nimmo's situation was rendered much more agreeable to him than if it had been on a more extensive foundation, in a more fashionable and popular place.

It was during the time that he held this situation that we first became acquainted with him, at the recommendation of Professor Playfair; and to meet, and commence a friendship which lasted till his death, were the results of one and the same minute. This was indeed the necessary and inevitable consequence of an introduction to Mr. Nimmo, if the party introduced was at all capable of appreciating his character.

Mr. Nimmo was naturally well-formed; his body was as firmly knit, and strong in proportion to its size, as his mind was vigorous. There was, indeed, no possibility of fatiguing him, either in the bodily or mental sense of the word. He was capable of enduring the hardest labour for the whole day and the greater part of the night, and this for many days in succession; and we have traversed moors and hedges, climbed precipices, jumped over ravines, and waded rivers with him the livelong day; and when at last we came after midnight to the sheltering covert, the lonely hut, or the superior mansion, as any of them chanced to be the place of rest, Nimmo landed in full vigour; and if it was a place where there were men who could understand and appreciate him, he would enter into an argument at those late hours, and after exertions which comparatively few could have borne, with the same alacrity and zest as though he had been fresh from his study or his couch. It seemed, indeed, as though mental activity had the same bodily

effect upon Nimmo, as sleep has on ordinary men, while it was inspiring instead of being, like sleep, lulling to others. It has often happened, that when night was closed in, in some lonely region, the voice of the birds of evening had ceased, and the angular fragments of stone began to cause pain in the sole of the foot, some stimulating subject, introduced by Nimmo, and carried on by him with great spirit, has made all the wearisomeness and hardship of the night forgotten in a moment. These conversations, too, though they partook largely of that argumentative character which was inseparable from the man, were always in a very high degree instructive; and though one was beaten in the argument, like lead on an anvil, one was in some sort like the party in Hudibras—

"For one's beating giving thanks,—"

so well did the blows consolidate and temper the mind for future argument.

These matters have nothing to do with Mr. Nimmo's talents, acquirements, or works, as an engineer, for he had not then engaged in that profession; but they are valuable, inasmuch as we rarely meet with any loophole, save his reports and his works, through which to contemplate his real character as an engineer or a man; and what we have stated is the result of long-continued personal experience, in which we do not misrepresent, and cannot be mistaken.

Mr. Nimmo's situation of rector of the academy at Inverness was a little higher than that which he held at Fortrose, because Inverness is a sort of metropolis to the north highlands, and this academy is constituted by a charter, and styled "Royal." The emoluments were also a little higher, though perhaps the difference was not greater than in the expense of living. But granting that it had, and that the academy had been royal in truth as well as in name, it is doubtful whether Mr. Nimmo was really so happy there as in Fortrose. The majority of the directors, who usually met and issued trifling orders from time to time, were the magistrates and official men of the burgh; and any one who has had experience of the state of things in a local metropolis, has no need to be told what sort of gentry they are who are girt with local authority. Professing almost every thing, they in reality know next to nothing; and thus, while their words have the sound of the former of these, their actions have the senselessness of the latter. Such were the party who tried to control and govern Nimmo; and from what we have said, it is easy to see with what feelings he would sit under such government. He did his duty well, and in a fraction of his time; but these parties could not understand why he was able to engage in so numerous and such varied pursuits, while the common routine of teaching was labour enough, and to spare, to the "dull dominies" with whom they had been familiar, from A. B. C. onward to "vulgar fractions."

True to his juvenile habit, Mr. Nimmo made himself thoroughly acquainted with whatever existed or was going on within the sphere of his observation, and he had now accumulated such a volume of knowledge, that he understood most subjects better than the parties who were professionally engaged in them. An instance of this occurred in a framed roof, which an architect, mason, and carpenter, of no small note and name in that part of the country, had constructed in Inverness for a new house, upon the usual principle of a great chest with a hog's trough turned bottom uppermost on the top of it, which he was erecting for a gentleman who had returned from the East or West Indies—we forget which—with a well-filled purse, and who had purchased land in an adjoining county. The roof, before being sent off, was put together and exhibited on a piece of waste ground, as a *chef-d'œuvre* of carpentering, and the most appropriate advertisement of the transcendent ability of the constructor. Nimmo was called to see this roof by invitation, in order, perhaps, that his opinion might be inserted in the newspaper, and we accompanied him. The architect wished him carefully to examine it, and give his opinion. Nimmo walked round it; and then, taking up a mallet, he, by very gentle blows, struck out a full third of the pieces of timber, saying to the architect, "If you have no other use for these, chop them up for fire-wood, as they are worse than useless in the roof." He then explained how timber may be used as a strut to resist a thrust, or as a tie to resist a pull; but that if, as he showed to be a fact in the case before him, the thrust and the pull upon the same piece of wood were equal, that piece of wood would be useless in itself, and act as a dead weight upon the really essential parts of the framing.

The superior talent which, though a very young man—little indeed past boyhood—Nimmo showed, caused him to be disliked. There was no vanity in his composition, but still there was a range and correctness in his knowledge of things, and indeed of persons too, which raised him so high, as to excite the envy and ensure the hatred of by far the greater number of those by whom he was surrounded.

But in spite of all the dislike in which such a man was held in his absence, there is a pretty general desire of feeding upon his works. This was the case with Nimmo, and the fact of its being so, greatly increased the envy of those about him.

But Nimmo found mental relief in another quarter: the Caledonian Canal was then in progress of construction; and the resident engineer and principal contractors, who felt none of these little jealousies, were his every-day companions; and the frequent visits of Mr. Telford raised the enjoyment to a very high treat. Independently of his general talent, Mr. Nimmo endeared himself to those gentlemen by his conduct. On the winter evenings he delivered lectures on chemistry, blended with geology and mineralogy, which were of real practical use to these parties, and for this they were grateful. Mr. Nimmo was partly prepared for the profession, by some works which he had been employed to do during his academical vocations,—such as the dictionary of positions for Arrowsmith's Map of Scotland, then in the course of construction, and other works still more nearly approaching to the character of engineering survey.

The inconsiderate conduct of the directors of the academy on the one hand, and congeniality of feeling with Telford and those under him on the other, gradually withdrew his attention from the petty drudgery of teaching in a local school, and turned it to the higher work of engineering. Before long, Mr. Telford found him an occupation as fellow-labourer with the son of the well-known Richard Lovell Edgeworth, in surveying a considerable extent of the Irish bogs, and reporting on the probability of their drainage and culture.

This survey was admirably conducted; and a mine, in the working of which they afterwards become partners, yielded a considerable revenue; but they embarked in something else, and were unsuccessful, and Nimmo, out of employment, expended a considerable part of his remaining balance in a tour over different parts of the continent. This tour diminished the contents of Mr. Nimmo's pocket, but it also increased his engineering knowledge;

and soon after his return he was appointed to regular employment, and so continued during all the remainder of his life, as stated by our correspondent. His principal employment was in Ireland; and though some of the Irish disliked him at the outset, he very soon became a general favourite among all classes; and, perhaps, there has not been a man, within the last hundred years, over whose bier the people of Ireland sorrowed so much as they did on that of Alexander Nimmo. Some may suppose that Ireland should have erected a monument over the last cold and lone dwelling of his remains; but the hearts of all Ireland are his monument there; and the stain is on this side of the Channel—a stain which has so long taken hold, that nothing which can now be done can wash it out. Before his demise he had made preparations for greater works both in Ireland and in England; but he was cut off in the middle of his years, and the full blaze of his glory; and, while different men have different appellations, his is NIMMO.

ACADEMICAL LECTURES.

FROM his own works, it might be imagined that the present Professor of Architecture at the Royal Academy set antiquity and authority at defiance, so egregiously has he in many instances, not only departed from all precedent, but manifested a taste quite at variance with the genius, both of the Roman and the Grecian style. Nevertheless, conveniently lax as is his own practice, his doctrine, as delivered *ex cathedrâ*, is exceedingly strict, not to say bigotted. Not satisfied with recommending the works of the ancients as models in point of taste, complete in themselves, he extols them in the most unqualified and outrageous manner, as being the very *ne plus ultra* of perfection in every respect. Undoubtedly such opinion is most orthodox, and an exceedingly safe one, inasmuch as it has been repeated *nem. con.* for the two last centuries—long before Grecian architecture was at all understood,—but with far more of assumption and presumption than of rational investigation. One very important question, which seems to have totally escaped the consideration of the learned professor, is, how far the style of the ancients can with propriety be adopted at the present day? that is, how far it can be adhered to by ourselves, in such manner that as little as possible of its original, or at least its genuine character, shall be forfeited? This is a problem that would have exercised the professor's skill and ingenuity, and would have afforded him the opportunity of saying something fresh, and rather more to the purpose than the stale observations in which he indulged.

Is it possible for us at the present day to adhere strictly and exclusively to the antique? We think not; and, if we mistake not, the profession are, to a man, precisely of the same opinion; not that they openly assert such opinion, but because their works plainly enough declare it for them, showing how impossible it is to keep up consistently the true classical spirit of antiquity in their buildings. Most certainly they are at liberty either to accept or reject the excuse we here hold out for them, but hardly can they do the latter without subjecting themselves to the charge of incompetency; whereas, in the other case, they must virtually admit with ourselves, that, admirable as classical architecture may be in itself, it can only, in very rare cases indeed, be now applied in tolerable purity, and without a greater or lesser admixture of heterogeneous elements and forms. To what purpose then is it to insist, with Professor Cockerell, on exactness of imitation, in regard to columns and orders alone, when such excessive license is allowed, or at any rate is taken, as his own buildings sufficiently testify, in almost every other respect? He who feels no scruple at putting two series of windows within a Grecian order, or putting windows at all within a portico, surely may, without any qualms either of taste or of conscience, allow himself a little liberty of invention in regard to such comparatively subordinate matters as cornices and capitals of columns; we say subordinate, because they are, in fact, no more than matters of detail, which do not affect the general composition and character of a structure. Little merit is derived from merely copied decoration, however excellent it may be in itself, more especially if it only serves to render the tastelessness of the structure to which it is applied all the more offensive.

Hardly has the professor been successful in applying Grecian or Roman architecture to modern arrangements and modes of construction: on the contrary, so far from exhibiting any felicity of taste in his designs, several of them are but *queer* compositions; as for instance, that strange architectural hotch-potch, the British Assurance Office in the Strand; nor, if we may judge from the drawing of it, will the Taylor and Randolph Institute at Oxford turn out much better, unless the design should now be purified from some of its most glaring absurdities and inconsistencies. No doubt it is an excellent thing to be a professor, and to deliver opinions without fear of being contradicted by the auditory present at them; but it would not be amiss, even for a professor, to bear in mind that, though they may pass unquestioned in the lecture-room, they may undergo some scrutiny out of it; and that if they are found to be no better, some persons—ourselves included—will allow them to be nothing but fudge.

RAILROAD ACCIDENTS.

BY A CIVIL ENGINEER.

THE recent accidents on railroads have, in most cases, arisen from collision, from the subsidence or settlement of embankments, or from slips of the slopes of the cuttings overlaying the rail or rails, and thereby causing a too sudden obstruction to the velocity of the engine and train.

By the adoption of due precautions, it is apprehended that all of these causes might be removed, and if the directors and shareholders of the several lines were to unite, and to offer a suitable premium, to be *honestly* adjudged and paid, for the best mode of doing so, there is little doubt that something beneficial would be the result. To prevent collision is obviously a mere matter of arrangement, and of too simple a nature to be included among the plans proposed to be called for, which should include only the best methods of preventing subsidence or settlements in the embankments, and slides in the slopes of the cuttings.

It is of no use to look for a remedy in any new arrangements of the rails, or in the adaptation of the engine. *Do what you will*, in these respects, a *momentum*, produced by a weight of twelve or fourteen tons, running with a velocity of twenty, or even fifteen, miles an hour, suddenly checked, would bid defiance to it all. The surest and the best remedy is to prevent *obstructions*. To this, therefore, their whole attention should be directed.

The engineers of the several railroads are no doubt talented men, at least the presumption is that they are so, but all the engineers in the kingdom are not employed on railroads; neither is it to be supposed that all the science of the profession is concentrated in or confined to those who are employed on them. It is not to be expected, however, that professional men will impart their designs off-hand to the directors of railroads, without some prospect, at least, of remuneration. We have lately heard, indeed, of projects being suggested to public bodies, and of the projectors being told "that their own very talented and respectable engineer was, at that very time (how curious) employed on a project having the *same object* in view." Delicacy enough in this at all events; but behold the end of it. Their highly talented and respectable engineer's project, on being exhibited, is found to tally exactly, in all its essential parts, with that which *had* been suggested to them; the only alteration being, that, in order to conceal the fraud, a *fictitious name* (totally inapplicable to the project) is given to their own "*very talented and respectable engineer's*" invention!

After this can it be wondered at, that men of genius consider it prudent to hold back, before trusting their plans into the hands of any body of men.

In a *pecuniary* point of view only, it may be noticed, that the passenger traffic on the Great Western line, for the week following the recent calamitous disaster, was upwards of £2000 less than that for the week immediately preceding it. If the directors be accused of having no regard to the cause of humanity, they cannot surely be taxed with insensibility to what affects their pockets.

T. W.

NOTE OF THE CONDUCTOR.

In another part of the present number, there will be found a general article on slips or falls of earth from the banks of cuttings, supplied by a gentleman who may be said to have a hereditary knowledge of these matters, derived from his father and more remote ancestors, in addition to his own personal experience; but in supplement to what he says, we shall make a remark or two on the recent slip on the Croydon Railway.

Every railway in Britain, whether on a large scale or a small one, and whoever may have been, or is, its engineer, is, in a geological point of view, wretchedly bad—bad in the plan, and bad in the execution.

In all cases where the earth in which the cutting is to be made is rock, or approaches to rock, or even is binding gravel, no ignorance of the engineer, or bungling of the excavator, can absolutely spoil it, or make the line a heavy and permanent expense, so as to cost more in a few years than would have made a good and substantial line at the first. This impossibility of being spoiled applies to all strata which have no tendency to absorb water into their substance, and by that means become soft and plastic. Gravel, though porous, will slip a little, because the water goes to the easiest exit, and therefore a portion will come oozing through the banks into the railway, but not so much as to occasion serious injury. Such soils should be excavated so as to have a lengthened talus, or heel, toward the railway. Chalk again, though but little absorbent, has vertical fissures, and, if it stands in a high perpendicular front, such as many of our seaward chalk cliffs, it will be wedged off by the water getting into those fissures. A moderate slope will, however, prevent this, and thus chalk may be said to form secure banks.

When, however, we come to the clay, be it London clay, Oxford clay, Wealden clay, or any other which is absorbent, but not a drainage, the state of things is altered. The line is most frequently laid down in an improper place; the banks have not slope enough, and no means are taken to break the hydrostatical pressure, which might be done by a series of slopes and terraces, or by indenting courses of brick-work laid in cement a considerable way into the bank. As for the ground, the hollow is chosen because it requires least excavation and embankment; but the hollow of a clay soil is the receptacle, in which, if the water does not stagnate on the surface, it stagnates in the clay, and reduces it to a kind of mortar, more or less plastic according to the quantity of the water. Thus these are the very worst slopes for the cuttings, and the very worst materials for embankments, and the consequence is, that there have been slips to a greater or less extent upon all the railroads which traverse the clays. Of these, the most frequent have been on the Croydon line, which follows as a matter of course, from that line being made close by, or actually in the bed of, the Croydon canal; but the particulars of this we must leave to another time.

STATE AND PROSPECTS OF THE ENGINEERING ARTS.

We had intended to procure an article on this subject for the present month, in order that it might find its way to at least some members of the House of Commons before the commencement of the ensuing session, but this has come to us in a letter of such length that we have not now room for it. Some parts of it are a little spicy, and might admit of perverted interpretation; and we presume the honourable and right honourable houses, especially the first named, will have coals enough to keep the fire going till the first of March. We shall, therefore, after passing one or two brief remarks, delay the main subject till then.

Never since the close of the general war have the prospects of these arts been so gloomy at the opening of a session of parliament as they are now, and never was there less prospect of their getting better. In 1825, there was indeed an attack of that mania to which Britain is so subject when she has been some time at peace, and, like Jeshurun, "waxes fat and kicks;" but at that time the fit was not so general, so long continued, and so hopeless of cure as it is at the present time. It appears that taxation has been reduced not only to the last farthing, but that our men in office must either levy some new taxes, or pinch the growing wants of majesty and its train. In this state public works are out of the question. Our correspondent says, that the repairs of the Breakwater at Plymouth were suspended, in order that the amiable king-consort might not be choused out of his dog-kennels at Windsor; and it is pretty well understood, that the christening of the young Prince of Wales—a ceremony which cannot be too augustly celebrated—will cost, including the fetching of the majesty of Prussia to stand sponsor, not less than £100,000 or £120,000; but it is many years since we were blessed with a Prince of Wales to christen, and therefore we must pay up loyally there, how much soever we may smart for it in other matters. This expenditure will blanch the visages of architects and engineers, and pinch the stomachs of the common file, but we must not let a Prince of Wales slip into the church without due honours. The only provoking part of the business is, that the little

fellow came sneaking into the world when the town was empty, and it is understood that he will be fairly made a member of the church before parliament meets; and this will take away our "tub to the whale," which the expectation of him would have enabled ministers to throw to the people; and this, besides the positive injury to the professions, will lay them open to the complaint of the people at a very vulnerable point. Putting all these together, the said professions can look for no public works, excepting, perhaps, more room in the palace for a go-cart or a baby house, which will be a mere nothing.

Then, as for the people, they are pretty clean drawn already, unless it be in obstructed cases, where no one can get the process to work. The railroads have drained every drainable pocket in the country, and as some of them will never pay, and all of them are subject to great fluctuations, they will put a stop to joint-stock companies, even those for the accomplishment of the most useful purposes, and place both the government and the people in that condition in which they cannot encourage the arts or improve the country in any of the ordinary ways; and this is the more to be regretted, that the time during which we are thus compelled to pause will be a time of good, and successful exertion to those who are our rivals. There is scarcely any department of our national industry, and certainly no industrious part of our population, which will not be paralyzed by this untoward state of things, and therefore it requires to be scrutinized with the utmost care, so as to do justice to it, and at the same time avoid politics.

AGRICULTURAL ENGINEERING.

LEAKAGE OF CANALS, AND OTHER WATER.

Every one who has travelled much in Britain, and used the eyes of even the most common observer, must have been struck with the sad neglect of the bounty of nature, the effects of which are spread all over the country. This is especially apparent in every thing that conduces to the productiveness of the soil. No doubt there are pet bits here and there in which the art of cultivation, and those other arts which prepare the soil for the successful efforts of the cultivator, have been carried to a very high degree of perfection. This, however, is by no means general; for, even in the best managed counties, a considerable portion is waste; and, taking the whole country, a full third of it may be said to be entirely barren, and half the remainder in a very backward and imperfect state. Even among the most highly cultivated and productive fields, there are as many patches, corners, green lanes, and road sides, lying waste and offensive to the eye, as would maintain half the pauper population; and this pauper population might, under proper management, improve them, and keep them in a productive state, and so far as it did this it would maintain itself and cease to be burdensome to the rest of the people. It may be pleaded that this population consists chiefly of old men and women, and children of comparatively tender age, who are not fit for work. We grant that they are not fit to be public contractors for regular wages; but we very strongly suspect that there are two classes of them, one the opposite of the able-bodied, and another the opposite of the willing-minded. The New Poor Law, with its injunctions to residence in the workhouse, has, no doubt, diminished the number of the latter class; but the disposition to be idle and dissipated had continued so long, and become so natural as a habit, that years must elapse before it can be eradicated. As preparatory to this, a sort of reformation must take place in the mind and feelings of that portion of society to which voluntary paupers belong; they must learn to be ashamed of that indolence which prefers beggary to honest industry before they can resist the temptation of even the workhouse; and such a reformation cannot be brought about without the lapse of a considerable time.

This co-instance between the neglected state of a good deal of the land, and the love, we may say, of the parish relief on the part of a portion of the people, is a curious circumstance, and the comparison of different counties shows that the causes of both are connected with each other. For, supposing an increased population, there is always a disposition to pauperism where there is neglected land; and where the land is well cultivated up to the last yard, there is less pauperism, or it is confined to the indolent and the vicious. The moral lesson here is a good one, for it shows, if a people will neglect the bounty of Providence, they must pay the cost of so doing, not only in the immediate neglectors, but in the whole people.

This, however, although a very important part of the subject, is not the one which is calculated to strike the ordinary and unreflecting observer. It is a matter of inference, not seen by mere inspection, but must be worked out by a process of reasoning. The plainer and more obvious case is that of the metaphysical consequences of neglecting nature's bounties, and therefore it demands our first and most general attention. The inferior state of the land compared with what it ought to be, is an effect, and not a cause; and as the certain removal of any effect is the removal of its cause, that cause is the main subject to which attention should be paid. The whole of what may be called the "Islands of fertility" are neglected; and, besides the immediate and positive neglect of any one of them, the neglected one always impairs the others. If the atmosphere, in so far as art can improve it, which may be done by breaking its violence with belts of timber and other shelters, by draining marshes, which taint it, and various other means, is neglected, it sweeps the most valuable part of the soil from the land, wafts disease to the dwellings of the people, and produces want and misery. If the land is neglected by allowing water to stagnate, useless plants to accumulate, and various other sources of annoyance to be formed and matured, it taints the atmosphere, scatters the seeds of useless unwholesome plants over the cultivated surface, and works mischiefs of various other kinds. Also, if the water be neglected by allowing it to accumulate on the surface of the ground or below it, by allowing it to flood the lands at one time, and leave them too dry at another, it also does evil, to which no cure can be applied except a better management of the water. Water, if we may so speak, is the element of fertility and wholesomeness, which man has most readily and completely under his control, and therefore the neglect of it is the most culpable neglect of which he can be guilty.

When the drainage of water from the earth, its removal from the surface, or the accumulation of it in places which are seasonally apt to be dry and burnt up, require extensive and costly works, the proprietor will not, generally speaking, be at the expense; and the renter of the land, especially if he is a tenant-at-will, or has only a short lease, cannot be expected to do it. Therefore, in the majority of cases, the improvements are left undone, and the state of things becomes worse and worse every day. If the renter of the land, circumstanced as we have said, attempts to make things a

little better, by patchworks which cost little at first, the thing is always ill done, the advantage small, and the cost in the end much greater. This points out, as clearly as can be done, that all these greater improvements of land should be made at the expense of the landlord, who ought to call in a competent surveyor and engineer to ascertain what ought to be done, the best means of doing it, and see it completed in a proper manner. This would, no doubt, cost a little money at the outset, but the cost would be expended for the benefit of the estate, and not of the tenant; and, therefore, the landlord would deserve and get rent for it just as if it were an additional breadth of land. The tenant could be bound by a clause in the lease—and in every taking of land there should be a lease,—to keep the drains, water-courses, tanks, and other necessaries for this purpose, in good order during the currency of the lease, and leave them in the same when he went out of possession. In this way the land-owner would have the benefit of such works as property, and the lessee would have the annual return as compensation for his rent, and for the cost of keeping the works in order. Thus, neither landlord nor tenant would actually sacrifice any thing in the end; but, on the other hand, there would be an additional return, greater than the additional cost, and more food for man and domesticated animals could be sent to market, or otherwise disposed of, at an increase of profit greater than the increase of price. We have said, however, that the landlord will not construct such works, and that it cannot be expected of the tenant unless a fair repayment is secured to him, with interest; and, between the one and the other, the improvement is neglected, the country is unsightly, and its produce is less. Thus, the neglect is a loss to the surveyor and engineer, to the tenant, to the landlord, and to the public generally. The landlord is the party who acts unwisely in the business, because the neglecting of the improvement rests with him—we, of course, speak only of those minor improvements which are confined to single estates; for in the more extensive ones there are more parties than one to be consulted. The actual expenditure can hardly be that which prevents such improvements, for the landlord generally expends larger sums upon matters which are useless, and bring no return to himself or any body else. Somehow or other, however, landlords are not over fond of surveyors, and they have a perfect horror of engineers. This is not difficult to be accounted for. A landlord is, generally speaking, very anxious for the improvement of his land, as every man is anxious for the improvement of his property, of whatever nature it may be; but the business has long been in the hands of quacks, by whom landlords have been previously bitten; and as there are comparatively few of them who can, of their own knowledge, distinguish a genuine man of sense from a quack, the sins of the latter are visited upon the head of the former, and the country suffers from one class of its population having been duped.

Passing over these matters, which may be said to be hopeless until a change takes place in the disposition of landlords, there are some not unimportant cases, of so slight a nature that anybody who is at liberty may attend to them. One of these is the adapting of leakage water from canals and other works, so as by irrigation to augment the product of the soil. In ordinary cases, it is not desirable that there should be any leakage in the canal, because, once begun, it is very liable to increase; and it is especially so guarded against in cases where the keeping up of the water, or the working of the canal, depends upon pumping, tanks, or any other artificial means. Water obtained in this way is always expensive, and, consequently, every precaution should be taken against its running to waste. But this cannot always be done, even in cases where the supply is scanty; for the nature of the soil may be such that no puddling can keep it water-tight for any great length of time; and there may be faults, also, in the engineer, and imperfect work on the part of the excavator, whereof the engineer may have had no knowledge until it shows itself in the leakage. If the banks are artificial, and no puddling required but in them, puddling afresh, though a troublesome and rather expensive operation, is not a very difficult one; but if the nature of the soil is such that both banks and bottom require to be puddled, repair in the case of leakage is a very difficult matter; and if the supply of water is pretty good, and the leakage trifling and not apparently on the increase, it may be allowed to go on. If the supply of water is unlimited, leakage is of still less consequence, only care should be taken that it do not extend to absolute drainage, or disruption of the banks, which in some cases it is but too apt to do. When the leakage water can be spared, and its quantity does not increase, except very slowly, the cost of making all water-tight will exceed the profit, and in this case, the best thing that can be done is to turn the leakage water to account. The most profitable account to which it can be turned is the irrigation of the fields upon which the water is discharged; but this cannot be done without some artificial water-courses and other works, and the turning of the surface into that form which suits with irrigation. This is accomplished by throwing the surface into ridges, with water-courses along the crowns, and waste drains in the hollows between; and if the water which trickles down the sides of one ridge can be sent to another by the drains, it is all the better, for a passage over a single ridge will very seldom exhaust all those substances adapted to an increased growth of plants which it holds in suspension upon entering the field. Throughout the greater part of the year, the water should be kept trickling slowly down the slopes of the ridges, but it must not be allowed to stagnate. If it is so allowed, the grasses will become coarse, moss will gather among the roots, and sheep pastured upon it will be subject to the rot, except for a short period of the spring. Such a meadow is not at all adapted for the growth of corn; and though originally laid down in the finest grasses, the hay will soon become worse in quality, and the ground dangerous as pasture. Occasionally, the water should be retained in the field as a flood; but this should not be too long continued; and it should be done while the grass is very short, and the whole of that should be covered. If it is between, and partly in the water and partly in the air, it will begin to decompose, and grass in this state is unhealthy, and injurious to the roots that are left. The deadliest poison which can be applied to any grass, is the matter of that grass in a state of decomposition; and this acts as a poison, not only on that part of the crop which is to be mowed or eaten down the same year, but also on the parts which are covered by the water, the roots which are in the soil, and the soil itself.

If the ground upon which the leakage trickles out in small quantities is a dead level, or slopes gently from the level line of the canal, without any longitudinal furrows, the water of necessity creeps along at an imperceptible rate, converting it into a sort of semi-morass, and first bringing upon it a coarse grass, intermediate between the tender grass of the meadow and the tough hard grass of the marsh, and if this state continues long enough, moss gets upon the surface, and the soil is in time covered by peat. There are some examples of this by the Grand Junction Canal near London,

but they are only in the first stage, and the progression advances very slowly. The cure for this, is a head drain immediately under the canal bank, and there seldom is enough of water for irrigation; therefore, the best way is to carry it off by one or more cross water-courses, and leave a dry meadow or arable field, as might be desirable.

When the leakage water is abundant, and the supply sufficient, irrigation may always be obtained if the ground is suitable for it; and it may be had without any leakage, by means of sluices and small tanks, wherein to keep a supply of water. In this way, a canal proceeding across an arid surface may be of great benefit to it, though this benefit is not always taken advantage of. The most porous and leaky canal upon earth is the Caledonian Canal, especially certain portions of it between Tor-y-vain and the system of locks at Muirton. The soil there is alluvial, of the loosest possible texture, consisting in great part of pretty large fragments of stone, seldom much, if at all, water-rounded, and so open, that a wind blows out from among them with considerable force, and one can push one's arm in literally to the shoulder, without meeting with much resistance. This extremely loose soil is not continuous the whole way, but one portion of it extends across a barren moor, and another across dry and hungry fields below the farm-house of Kimmylies. These are the places at which the leakage is greatest; and though large sums were expended in puddling, they had not the desired effect. A good deal of the water unquestionably runs out from the canal, but a portion more may pass under the puddling of the bottom, and rise up on the lower side from the lessening of the hydrostatic pressure. Wherever it comes from, it comes in abundant quantities, so as to flow up from the base of the lower bank in perennial rills, which rills might be turned to the irrigation both of the sterile heath and the hungry plain. Such has not been done, or, at least, it had not been in 1819, the last time we visited the place; and as the canal has ceased to be a favourite subject, we suppose it is not done now, and never will be done. This leakage had worn water-courses along the heath, which were hollows with washed sand, and we do not believe there was a single plant more of any kind than if they had not been there. Upon the miserable fields again, the water ran in the furrows without doing any good to the soil, and the crop both of corn and of grass was as scanty as ever, every two stalks being almost their own length apart, and all as poor as possible. Now, if the water had been applied to these same fields in the way of irrigation, they might, by this time, have been very fertile.

BROTHER JONATHAN, THE AMERICAN STEAM PILE-ENGINE.

A PILE ENGINE, bearing the name of "Brother Jonathan" on its front, which has been much used in the United States, but never previously, we believe, seen in this country, is now employed in driving piles close by the bank of the river in Pedlar's Acre, Lambeth, not far above the southern abutment of Waterloo Bridge. These piles are not very long, but they are of substantial thickness, and are intended to support the Surrey abutment of the Suspension Foot Bridge, which is to extend from this point to Hungerford Market on the opposite side. We shall not now dilate with minuteness on any one part of the engine, because the Colonel who is commander-in-chief of it has not yet, we believe, got his specification lodged and his patent for Britain secured, which is the main object of his expedition here; and to prevent all possibility of anything like misunderstanding about the engine, he has brought one with him and set it to work, in order that all those who may feel interested or curious in the matter may see it in operation before the patent is secured. This we must say is manly and liberal, and sufficiently proves that there is no deception or unfounded pretence about it.

Folks must not wonder that a colonel has come from America in order to take out a patent for a pile engine, for in that country there are colonels following all occupations, from the drawing of a sword in war to the drawing of small beer in peace. Besides, there was a time when Bonaparte was frowning at us across the Channel, but could not get over for the adverse winds—of the bullets of our ships, when things had come to such a pass with us, that every "minor," whose friends had got influence enough with the ruling powers, general or local, was a "major," and in the northern part of the island there were more instances than one of the major crying for his porridge. We should mention these little things, which were so common among ourselves, before we venture to joke any other nation, and more especially the Americans, about the particular classes and occupations of *men* upon whom sounding titles are bestowed.

But we have in the meantime to speak of the pile engine and not of the Colonel, and for the reason we have stated our remarks shall be few, loose, and general. In plan, this pile engine is a very complete and at the same time a very compact piece of apparatus, and, as is said of man in the comedy, "it plays many parts." It is moved by a steam engine of eight or ten-horse power, more or less, according to the duty which it is called upon to perform. This engine is raised on the platform of the apparatus, and it is a high-pressure one, occupying, with its internal boiler, a very small space. Certain oblique motions, or rather apparatus for producing such motions, form the characteristic parts upon which the patent right is grounded; for no man could obtain a patent for simply applying a steam engine to move a machine of this sort, any more than for applying it to move a steam ship or railway train. Of this part of the apparatus we therefore say no more in the meantime.

The motions produced by this engine are many; it moves the whole backwards, forwards, or obliquely, so as to bring the cheeks which enclose the pile, and between which the monkey falls, directly over the spot where the pile is to be driven. It lifts up the pile on end by shears, so that it can be suspended in an exactly perpendicular position before the blows are struck which drive it into the ground; and it raises up the monkey, so that it may either be unhooked by the shears at the top of the fall, or by a manual operation when it is not raised so high. This last is rather a clumsy mode of proceeding in an engine pretended to be so complete; and moveable shears, which could easily be contrived to descend to the point wanted and hold on there when pressed by the monkey drawn up against them, would look neater and be more convenient. In addition to what we have already stated, there is below the platform a circular saw, which moves in a horizontal direction, and by being brought by an oblique motion to a pile, which will either drive home no farther or is already driven home as far as wanted, it cuts off the superfluous part by a horizontal section; thus there are many motions originating from the one first mover, and they are all in different directions; but whatever may be the direction, they are all called "moving a-head" in American phraseology. So it seems to be understood by the men employed about the engine;

for the invariable command for starting any one of them is "go a-head," ordered by the commander on board. While we were looking at the working, well pleased with the general idea, but not so much with the execution, we were standing close to, and indeed leaning on the fore part of the engine; upon hearing the command to "go a-head," we receded from the front, expecting that the engine would be moved towards us; but it was moved obliquely backwards, at a snail's pace. So also we observed one of the men close by the cheeks adjusting some part of the apparatus, and when he got the command to "go a-head," he stepped as quickly as he could to what we should have considered the very stern of the platform. We mention these trifling differences of language, merely to caution such of our readers as comprehend ideas only through the medium of words, not to be taken in their own snare. To "go a-head," in the American understanding of the term, is simply to go in any direction, or proceed to do any thing; and the man so ordered is always understood to have sense enough to know what he ought to do in obedience to the order.

The plan of this engine is, as we have hinted, very good, but the workmanship is clumsy, and there are several parts of it, of which the most is not made. Some of the cast-iron work we observed to be very much honeycombed, and the forged work was clumsily hammered. The monkey and its apparatus seemed the worst parts, especially for driving piles in British alluvion, where the clay is mixed with hard gravel and very large pebbles. We have no doubt that in the more uniform and soft banks on the shores and estuaries of America, this monkey, from its great weight, and the long fall from the shears at the top, must drive a pile home "slick" at a few blows. This monkey is in fact a queen of monkies, a perfect ourang-outang or baboon of the largest size in cast iron, and in the somewhat indurated beach at the Pedlar's Acre it came upon the pile like thunder at the first blow, and sent it eight or ten feet downwards into the earth; but when the pile was nearly driven home, and the resistance on the under part of it became very great, the blows are too heavy, and tell in a very different manner, shattering the top of the pile without driving it home a single inch; indeed, the fall is very much shortened, and even then it moves with difficulty, and splits. Hence it does not appear that the nature of such soils as ours, especially such as are mixed with gravel, had been properly taken in account when the engine was constructed, otherwise the monkey would have been made lighter. From the extreme force with which it strikes the blow, if there is much resistance on the pile, it is not at all propagated to the point, which it would be in the case of a lighter monkey, whose blow, even though much more feeble, would be propagated along the pile, instead of being wasted in splintering the upper part. This, however, is an evil which might be remedied, either by making the monkey lighter, or by shortening the fall; and the fact of a man having to loosen it out of the lifting shears with a crow-bar, when the fall is very short, is pretty strong proof that the piles are not subjected to the same consequence when driven in the softer and more uniform alluvion of America. The descent of the spring sheaves, which disengage the monkey, to the fall required, might be effected by a trifling addition to the general machinery, and by this means the whole operation would look a little more business-like. A succession of lifters, on an endless rope, which should lift up the monkey the instant that it has struck, without any interruption of the going of the machinery, would also be a great improvement. These, however, are all matters of detail, and do not affect the principle of the engine, which, as we have stated, is excellent in itself, only it is not worked out to the extent and in the perfection which we could desire, and of which it is worthy. As hinted, it may answer exceedingly well for driving piles into the alluvial banks and soils of America, where there is in general a great depth of uniform materials, and those materials of a yielding nature; but it certainly would require some alterations in order to make it perfectly efficient for pile-driving in this country. Of these differences of soil, and consequent resistance to the driving of piles, the Americans could not be aware; and, therefore, they have brought over the engine in that state in which it has been found to act so well in their own country; but they must not be too wise, and resist the alterations which would make it equally effective here. These they can make the more readily, that none of them can affect the patent right, or be patented by any other party, because this is the only engine to which they can be applied. The adjustment of the weight of the monkey and the fall to the work to be done, a constant motion of the lifting part, while the pile is in progress of driving, and the engagement or disengagement of the parts occasionally used, as may be necessary, are the grand points to which attention should be directed, and where improvements should be sought.

On the first point, what is to be determined is, so to adjust the weight and fall of the monkey as that the blow may be the most effectual possible in driving the pile, without shattering, or having a tendency to shatter, the upper part of it. It is probable that there is a difference in this respect in American piles, as well as in the earth into which they are driven. We know not whether they generally use pine timber for piles in that country; but if any other is used, the same observation applies. But pine is more liable to split and shiver, when struck on the end of a log, and the propagation of the blow is more resisted along the length of the log, than almost any other timber whatsoever. Pine timber, too, is always the more easily split and shivered, the more completely the annual rings or growths are ripened; because, in that case, each ring is more firm and compact in itself, and is less united to the other rings than when the ripening of the individual rings is imperfect. We have seen short pipes made out of the lengths of hard-grown pine, between knot and knot, by simply striking out a portion of the centre by a round piece of timber. This is very easily done when the red wood is struck out, and only the sap wood left; but it cannot be done in the sap wood, or in spongy timber which is only of sapwood consistency throughout its whole mass. Several of the American species of pine are entirely of this sapwood character, and all of them approach to it; and, therefore, though they fur on the end when driven as piles, they are but little liable to splinter. American pine is not generally used, and ought never to be used, for piles in this country. Baltic timber, generally Memel logs, are used for this purpose; and of all pine timber they are decidedly the best adapted for it, on account of their durability, and the quantity of turpentine with which they are impregnated. But they are hard-grown timber, in which the rings are very distinct, and the softer parts between them well marked, so that they are liable to split under circumstances which would merely fur the end of an American log. The comparison here has not been carefully made by actual experiment, but the fact of the difference is unquestionable, and it ought to be ascertained, and the blows of the engine regulated accordingly.

Pine, even of the best quality, and though the engine were adjusted with the utmost care, so as to drive the piles without

splintering them, is by no means the very best timber for this purpose. It may be the best timber that can be procured in Britain of the requisite thickness,length, and stoutness, and perhaps nothing is better than Memel timber, and certainly nothing equal to this timber could be imported from Canada or New Brunswick. The larch of Europe, which has its native locality in the Alps, and their south-eastern continuation between the Adriatic Sea and the southern branches of the Danube, is unquestionably the best timber for piles. If grown on too flat a surface, and soaked with the rain, it is friable, and apt to snap across, but there is no danger of this in driving a pile by blows fairly on end, or in the line of its axis. When rightly grown it is straight, clean, and not liable to splinter, and under water it is the most durable of all timber. Therefore, if it could be had in sufficient quantity for piles, the operation of piling would be greatly improved, and foundations of this kind rendered scarcely less durable than foundations of brick or stone. But the expense of importing larch timber to Britain, precludes the possibility of employing it for this purpose. The way is long, and consequently too expensive for an article, the bulk of which is so great in proportion to its price; and then, the fetching of it out of the wild rocky districts in which it grows would be more expensive than the voyage itself. The means of floatage to the Adriatic are few, inconvenient, and difficult, compared with those which facilitate the operations of the lumberers in St. John's and other parts of America; and as for land carriage over so rugged and irregular a surface, it is altogether out of the question.

The people of Britain have to thank their own folly or oversight for being so long without an abundant supply of larch timber for piles. It is true that the tree is not native in Britain, and the time of its first introduction is not very remote; but there are some larch trees in the country, especially in Atholl, which are unrivalled in stateliness and stoutness of bole by any timber in Britain. Instead of being choice as to soil and delicate as to constitution, larch will grow, and grow well, in places where no other tree will rise higher than a large bush; and its growth is rapid, and the timber good at all ages, from the size of a small spoon to that of a stately mast. Rapid, however, as is the growth of this timber, it will not, like a mushroom, spring to its full size in a single night; and, therefore, though planters of timber should pay proper attention to the larch, half a century would have elapsed ere our engineers and architects could have a proper supply of large piles.

The second point to which we have alluded, namely, the constant motion of the lifting-rope all the time that a pile is driving, is also of considerable consequence. It is so in point of economy in case of any pile engine, and it is so especially in the American engine for a reason about to be mentioned. Although the steam engine employed in "Brother Jonathan" is easily stopped, and as quickly started again, both operations require some time, and are attended with a loss of power. The engine strikes very fast, but the descent of the lifting rope and lifting shears, every time that it strikes, is an additional loss both of time and power, and the effect of each blow is exhausted upon the pile, and that brought to a state of rest, before a second blow can be struck. Therefore, each blow is a beginning, and derives no advantage from those previously given. Now, every one in the least acquainted with machinery must be well aware that a continued momentum is half the battle; and that when a body or piece of matter is once started into continuous motion, a much smaller power will carry it on than that which was required to start it at the first. When the motion is produced by percussion, or repeated blows, it is not very easy to procure a momentum, and in the majority of instances this is not required. In driving a pile, however, and in every other case in which a body is merely to be moved without any alteration in its shape, a momentum is highly desirable, and it is especially so in the operation of pile-driving. We do not say that a momentum could, to any considerable degree, be obtained by an improvement upon "Brother Jonathan;" but if the monkey were hooked up the instant that it strikes, and let fall again in a few moments afterwards, the effect of the second blow might be brought to tell before that of the first one were completely exhausted, and this would give at least some momentum, and thereby increase the effect of every blow after the first. To do this anything like effectively, would require a very nice construction of the lifting-tackle, and great rapidity in its motion. But the nicety of workmanship and adjustment is within the power of a skilful mechanic; and far greater rapidity of motion can be obtained by means of the steam-engine than by the labour of men or horses, which are the means usually adopted in this country for the working of pile-engines. Independently of the momentum, the steam-engine is vastly superior to animal power, which, though it may be increased by additional numbers, cannot be accelerated by that means. Two horses, for instance, cannot run farther nor faster than one horse, because their velocity cannot be collected into one. Even in the cases of additional numbers, the effect does not increase in their ratio; because, though two horses can draw more than one horse, their joint effect is not equal to the sum of their separate effects; for, however carefully they may be trained, they never can be made to exert the whole of their strength at the same instant. Powers of a steam engine, are, on the other hand, perfectly combinable, both in velocity and in force; and thus, if one steam-engine is made for one-horse power, and another for a power of two horses, the second will do exactly double the work of the first, and this may be turned either to the overcoming of work, or the overcoming of time. To both of these it applies equally; and therefore there is a power of increased velocity in the steam-engine, which cannot be obtained by horses, or any other animals. Thus, for instance, a steam-engine constructed as equivalent in power to a moderate number of horses, will impel a pretty weighty train at the rate of thirty to fifty miles an hour, upon a railroad; but though all the horses in the country were collected into one troop, they could not convey a single feather at anything like even the slowest velocity that we have named.

This is a vast advantage, though one which is but too frequently overlooked. If a greater velocity is desired, it may be obtained directly from the engine itself, with very little additional machinery, and consequently equally little additional friction, which is a great saving of power in the case of rapid velocities. But if, on the other hand, the moving power is animal, mechanical means are required for bringing up the velocity beyond even a moderate degree, and in all such cases power must be sacrificed, in order to obtain the additional rapidity of motion. All these mechanical contrivances, for converting a slower velocity into a more rapid one, are similar in principle to the driving of a small pinion by means of a large wheel, which is always done at a great loss of power, and with much additional friction; and if there is a series of such combinations, the resultant power, applicable to the work, may be only a small fraction of the grand power which gives motion to the first part of the mechanical combination.

According to the principles now stated, a very great degree of

velocity may, with very little, if any, sacrifice of power, be given to the lifting apparatus in the American pile-driving engine; and this is one of the chief reasons which we have for believing that a proper improvement of that engine might keep up a momentum upon the pile, during the whole time of driving it. As it now is, this engine drives piles more expeditiously and cheaper than those which have been in use in Britain; and if it were so constructed as that the momentum might be acquired, this would increase its superiority in both respects.

We stated, at the outset, our reason for not giving a detailed account of the working part of the engine, but we are under no restraint in the making of these general observations upon the principle and improvements. They are important, as well as necessary, because piling is a a tedious and expensive operation, and eminently worthy of consideration and improvement.

PILE-DRIVING MACHINES.

According to the modern practice in this country, the contractors for public works are more interested than the engineers in the improvement and performance of engines for driving piles, since the latter are usually content with specifying the dimensions of the piles which are to be driven down with a ram of a certain weight, the blows of which are to be continued till a given number of them shall not cause the pile to sink more than a very small stated depth; and then the business of providing an engine of suitable capacity for so driving them is left to the contractor himself. Every engineer, however, engaged in the actual superintendance of work which is under contract, will naturally, if he follow the impulse of an inquiring mind, feel it necessary to make himself acquainted with all the machinery and implements made use of by the contractor in the prosecution of his work. The engineer, by his superior education, and by the more extended opportunities which he possesses of applying his attainments in science, must be more fitted than the generality of contractors to suggest and to organize improvements in machinery; and, considering that every improvement which tends to reduce the price of any description of work, produces either directly or indirectly an advantage to the company by whom he is employed, as well as to the contractor, it is obviously the duty of the engineer to embrace within his consideration every improvement, whether suggested by his own researches, or by those of others. In addition to this, it ought to be remembered by the great body of rising engineers, that the particular policy, which at present prevails in Great Britain, of committing the execution of all the great public works to a class of men termed contractors, may not always continue, but, on the contrary, the companies associated for the execution of such works may choose to take the construction of them into their own hands to a much greater extent than is now usual; and whenever this change takes place, the whole burden of the contractor's duties and responsibility will fall upon the engineer, who will then have to exercise his ability and his knowledge with reference to the judicious application of machinery, as well as on many other topics which at present claim too little of his attention. We fear there is too much of that smart conceit amongst many of the younger members of the profession, which induces them to treat with indifference certain subjects of inquiry which they choose to term the business of contractors, and not their own. We should much like to follow such an aspirant after the fame of eminence in his profession into the wilds of New Zealand, or any other new colony into which his destiny might lead him. Too soon he would learn the value and importance of those precious opportunities of studying the expedients of contractors, which he may have fatally neglected in this country. How earnestly can we imagine him lamenting the state of things which throws him so completely on his own resources,—an emergency for which his arrogance and conceit had so ill prepared him during his engineering education.

ORIGIN OF PILE-DRIVING MACHINES.

The pile-engine, like most other machines made use of in engineering works, is not in its present form the contrivance of a single individual, nor the result of an uninterrupted train of thought; but has on the contrary, at irregular intervals, been improved from a very rude original until it has become the perfect and highly useful machine we are accustomed to see in operation when extensive pile-driving is in progress.

The origin of the pile-engine was probably a heavy wooden mallet or beetle, with which a man, standing on a stage, would contrive to force down small piles or stakes for the purpose of forming dams or stanks. The workman, in using such a beetle, is accustomed to swing it round, so as to describe in the air nearly the whole circumference of a circle, and then, when it has reached its highest point, to suffer it to descend on the head of the pile. The blow thus given is probably not more than is due to the mere fall of the weight from the height to which the man's arms are able to raise it; so that, taking the weight of the beetle at 50 lb., and the height to which the workman raises it five feet above the head of the pile, it will at once be seen how puny and powerless a contivance this was for driving any thing like a heavy pile. The force of the blow given under the circumstances we have supposed would be about 900 lb., that is to say, each blow would have the same effect in driving down the pile as a pressure equal to 900 lb. placed upon it.

An expedient by which piles of somewhat larger dimensions could be driven appears to have been used at a remote period in France, but the loss of power was so great, that it can scarcely be called an improvement on the more simple plan of driving with an ordinary mallet or beetle. A log of timber formed by the trunk of a tree, weighing about 200 lb., and of which the length was equal to about twice its diameter, was furnished with five or six projecting handles, by means of which as many workmen standing round raised it to the height of several feet above the pile, and then allowed it to fall, thus producing an effect varying from 2,000 to 3,000 lb., according to the height from which the blows were given.

THE RINGING ENGINE.

Compared with such pile-driving engines as the preceding, the ordinary ringing engine is one of immense power, as the blows can be given with much greater force, and with considerable rapidity. The name *ringing engine* was probably derived from the resemblance which the work of the men in raising the weight bore to the operation of ringing bells; and while in England this resemblance gave rise to the name of ringing engine, in France the engine itself was termed *sonnette*, bell.

The principle of this engine simply consists of a contrivance for enabling a small body of men, varying from six to eighteen or twenty, to raise a wooden weight, well hooped with iron, and

termed a *monkey*, to the height of four or five feet, and thus to produce a rapid succession of blows upon the head of the pile. It is composed of two upright posts, well tied together at top and bottom, and enclosing at the top a pulley, over which passes a rope; to one end of the rope is affixed the monkey, which is made of a great variety of different weights, from 200 lb. to 1,300, according to the work to be done; and to the other end a number of short ropes, varying from five or six to as many as thirty, each of which is grasped by a workman, and then, all pulling together, the monkey is raised to the height of a few feet, and immediately allowed to fall on the head of the pile. The usual system of working is to give a volley of twenty-five or thirty blows as rapidly as possibly, and then to halt for a few seconds and again continue the blows, by which means piles of ordinary dimensions are driven in good ground with tolerable rapidity. It should be understood that in working this engine the men continue to keep the ropes in their hands during the whole time of the volley, and that the monkey is never, during the driving, disengaged from the rope to which it is attached. It is this peculiarity, connected as it is with the comparatively small height to which the monkey is raised, that principally distinguishes the ringing engine from the improved pile-driver, in which a heavy iron ram is employed.

It is evident, that when the pulley over which the rope passes is of small diameter, a considerable loss of power is occasioned by the obliquity of the ropes which are pulled by the men, and also by the circumstance that part of the power exerted by each man is necessarily expended in pulling against the others. A consideration of these evils has given rise to an improvement by the French engineers, who have substituted for the pulley a wheel of four or five feet diameter, which enables the men to pull the ropes in a direction more nearly vertical; and it is said that, from accurate observations made during the building of the bridge over the Seine at Poissy, sixteen men were able to do the work of twenty, when the latter pulled over a small pulley instead of a wheel. In using a monkey of 8 cwt., where twenty men are employed, the weight which each is required to raise will be about 44 lb.; and where sixteen are able, by the substitution of a wheel for the pulley, to do the same work, each man will raise 56 lb., or half a hundred weight. In order to estimate the effect of manual labour so employed, the data required, in addition to the weight raised, are, obviously, the height through which it is so raised, and the time which each percussion occupies. We shall assume the height to be four feet, and, with reference to the time of each percussion, it appears, from the best observations, that, with a monkey of 8 cwt., a volley of thirty blows may be given from this height in one minute and forty seconds, and that twenty seconds elapse by way of halt between each volley, making in all three minutes as the time for thirty blows during a continuance of working. Thus, each percussion is made in six seconds, which, it should be observed, includes the time of descent, namely, half a second; but, as it is the useful effect which is to be determined, it is of course necessary to take into account the whole time of ascent and descent. We find then, on these data, that each man raises 56 lb. to a height of four feet in 6″, or 224 lb. to the height of one foot in 6″, or 37 lb. one foot in one second. This result is certainly much below what is usually estimated as the mean effect of human labour, namely, 100 lb. raised one foot high in a second for ten hours a day; it is also very different from the estimated force exerted in ringing bells, although the mode of exerting the force is in both cases as nearly similar as possible. According to the experiments of Dr. Young and Mr. Buchanan, the force exerted in ringing is equal to 1·428, taking the mean effect described above at unity, or it is equal to 143 lb. raised one foot high in a second. This is probably very nearly the actual force exerted by men in driving piles, but it is at the same time certain, as we have seen, from the disadvantageous application of that force, that the useful effect produced is only equal to 37 lb. raised a foot high per second, or about one-fourth of the comparative force exerted.

In modern practice it is not usual to assign so much of the weight of the monkey to each man as we have stated above; for instance, a monkey of 200 lb. is frequently worked by ten or twelve men, and one of 4 cwt. by fifteen or sixteen; but in these cases the rapidity of the blows is greater, as twenty-four blows per minute may be given with a weight of 200 lb. This performance shows a force exerted rather exceeding what we have before calculated, namely, one equal to 46 lb. raised one foot high per second instead of 37, from which it appears that 29 lb. per man is a more advantageous weight than 56 lb. The sheeting piles for the Lary Bridge near Plymouth were driven by a ringing engine, with a cast-iron ram weighing 450 lb., worked by seven or eight men, or from 56 to 64 lb. per man.

PILE ENGINES OF VARIOUS CONTRIVANCE FOR DISENGAGING THE WEIGHT FROM THE POWER APPLIED TO RAISE IT.

When it became necessary, during the progress of great engineering works, to apply a greater power in the driving of heavy piles, it was obvious that this was only to be effectually obtained by raising the weight to a greater height than was practicable from the nature of the power employed in the common ringing engine. At the same time, it was necessary to devise some means for instantly disengaging the weight when it was raised to the top of the frame, so that it should fall with perfect freedom upon the head of the pile. On this principle, the engine termed Camus' was designed in common with all the succeeding pile engines, only that the contrivances for effecting the fall of the weight have been variously modified in different engines, as will hereafter be described. In Camus' engine, as well as in all the others where the weight is raised by machinery, instead of being simply drawn up by a rope passing over a pulley, (an application which of course gives no mechanical gain of power) the weight is made of iron, and is termed a *ram*, in contradistinction to the wooden monkey of the old engines. We shall now briefly describe the machine invented by Camus, which was so contrived that the ram was raised by means of a weight passing over a pulley at the top of the frame, and which then descending, was wound round a drum whose axis was vertical. On the shaft or axis of the drum, and below the drum itself, was a capstan, which was worked by men turning round the capstan bars in the ordinary manner. The connection between the drum and the capstan is such, that when the men were heaving at the bars to make the capstan revolve, the drum also revolved, and, by means of the rope coiling round it, the ram was raised to the top of the frame. By pressing down a small lever fixed on the capstan, the connection is now broken off between the drum and the capstan, and the former, *freely revolving on its axis, allows the ram to descend on the head of the pile.* The rope is by this descent uncoiled from the drum; but when this is again connected with the capstan, the weight is raised as before, and so the process continues. It will be observed, that, in driving piles with this engine, the ram is never

disengaged from the rope by which it is drawn up: this distinction is important, because it is this which furnished the next improvement in pile-driving machinery. There is very little mention of Camus' engine by the old French engineers, who seem at an early period to have adopted various expedients for disengaging the ram from the rope itself, without having recourse to the clumsy expedient of a drum alternately fixed and revolving on its axis, with the additional disadvantage that the ram in descending had to overcome the friction of the drum on its axis, as well as its own friction against the timbers of the frame.

Fig. 1.

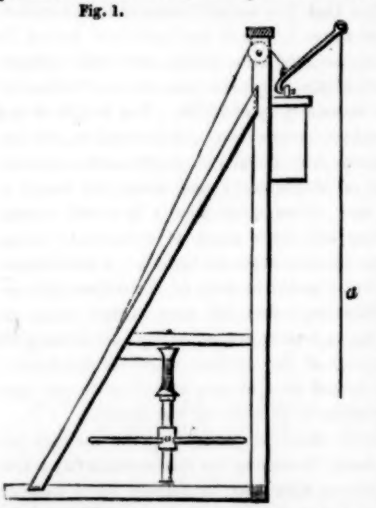
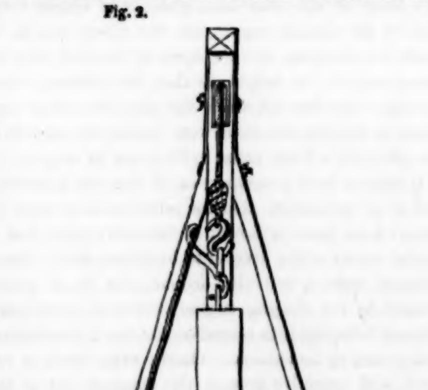


Figure 1 represents one of the earlier contrivances for disengaging the ram. It consisted of a short lever, with a hook at one end of it, which, when the weight was required to fall, was easily disconnected from the ring of the ram by pulling the small cord *a*, and a great number of engines were constructed with this contrivance. In some of these the cord was pulled by a boy standing at the foot of the frame, and in others the end of the cord was fastened to one of the timbers of the frame, and when the ram reached the top, the sudden stretching of the cord produced a jolt or tug, which effectually disengaged the ram, and allowed it to fall. (See fig. 2, which shows an engine of this construction) In other engines, there

Fig. 2.

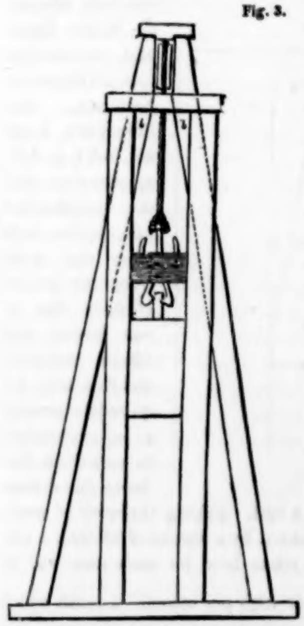


as a projecting pin of iron near the top of the frame, against which the end of the lever struck when arrived at a sufficient height, and this contrivance, which it would seem was more simple and effectual than the cord, is in use in many engines at the present day.

The next decided improvement in the efficacy of the pile engine, was made by the introduction of a separate block of wood above the ram, which block contained a pair of tongs or clippers for taking hold of the block; and when these tongs were opened, according to the contrivance we shall presently describe, as soon as they reached the top of the frame, the ram instantly fell freely to the bottom.

Figure 3 exhibits the form and action of these clippers, which are shown in the act of raising the ram. The axis of the tongs on which they open and shut, passes through the cheeks of the box, and to the top of the box is affixed the rope, from which it will readily be understood it is never disengaged. This box is by some termed the monkey, and by others the follower, from the office it performs of following the ram after its descent, and taking hold of it to convey it again to the top of the frame. Suppose the ram resting on the head of the pile after a blow, the follower is allowed to descend, which it does by its own weight, and the tongs coming down upon an angular bar, with one of its angles uppermost, which is fixed into the ram, open to receive this bar, and are immediately raised, bearing the ram up with them. When arrived at the top of the frame, where the opening between the uprights is contracted by the diagonal braces *b b*, the upper limbs of the tongs are pressed together, which immediately causes them to open at the bottom, and allow the ram to fall. The follower then descends to conduct the ram to the top, and the same process is repeated. Fig. 4, shows the tongs on a large scale, without the box; and fig. 5, shows them just opened, and allowing the ram to fall. The great superiority of the tongs or clippers over the contrivances before described for disengaging the ram, is, that they open of themselves to take hold of the ram when they are lowered down to it, whereas the hooked lever required the attendance of some person to hook it on after every blow. The office of the wooden frame or follower which moves between the upright posts, is, to keep the clippers steady in their descent, so that they may, without danger of slipping, take hold of the ram at once.

Fig. 3.



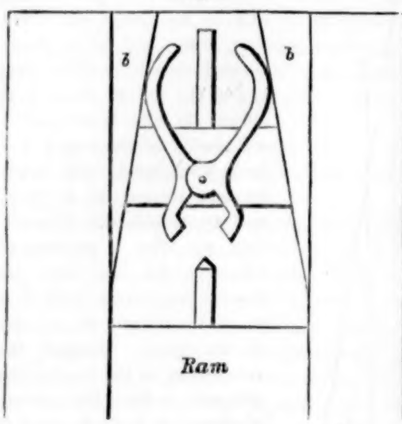
Probably the first engine in which the clippers were used, was that invented by Vauloüe, a watchmaker of London, and successfully used for driving the piles of Westminster bridge. His machine was constructed on a larger scale than any which had before been used, the weight of the ram being one ton, and the drum for raising it being worked by horses. In this engine, there were several in-

genious contrivances, although, upon the whole, it was somewhat complicated.

Fig. 4.

In the construction of the Potomac aqueduct, a work of great magnitude, completed in America within the last ten years, the pile engines for driving the main piles were worked by horses, and the rams weighed about 1700 lb. each. Smaller engines, with rams of 1300lb., for driving the sheet piles, were worked by a tread-wheel, and the performance was said to be much superior to that of engines worked in the ordinary way. From the excellent account by Major Turnbull, published in the Civil Engineer, Architect, and Surveyor's Journal, vol. i, p. 147, appears that, with the tread-wheel pile engines, each blow was made from the height of forty feet in one minute and fifteen seconds; and that they required six men and a superintendent to work them. The horse pile drivers made a blow in one minute and a half. Taking the work of seven men treading on a wheel to produce, by a weight of 1300lb., a percussion in 1′ 15″, the useful effect here for each man will be $\frac{1300\times40}{75\times7}=99$lb. raised one foot high per second—a result which agrees remarkably with the mean estimated effect of human labour, as might be expected from the very advantageous manner in which the power is applied. The constant treading of men upon the boards of a wheel, is similar to the labour of walking up stairs without any load, and although it is said that the maximum effect is produced when the man carries a small weight, yet it is seldom in the application of human labour that the useful effect is found so great as determined above, where the weight raised by each man is simply that of his own body, or on the average about 150lb.

Fig. 5.



The reports of the inspectors of prisons furnish some curious information as to the amount of tread-wheel labour in the various prisons throughout the country. We find from these reports, that the daily amount of labour in feet of ascent performed by every prisoner, averages more than 10,000 feet in a day of eight hours, although there are some instances where the labour performed is more than double this: for instance, in the Borough gaol and House of Correction at Grantham, Lincolnshire, the height of each step made on the wheel is 12 inches; the number of steps made per minute is 78, and the time of working, 9 hours. If each prisoner worked the whole of this time, he would perform an ascent of 42,120 feet in 9 hours, which is an amount of labour equal to raising 195lb. a foot high per second. As it appears, however, that in this gaol, only half the prisoners are at work on the wheel at one time, the labour of each during the day is equal to half of the above, or to 97½lb. raised a foot high per second, during a continuance of 9 hours; and is not quite equal to 195lb. during a continuance of 4½ hours, because the times of labour and rest are alternate, at short intervals. We would humbly suggest to the authorities that these unfortunate prisoners are considerably overworked in this gaol, and that they are still more so in the gaol of Montgomery, where the actual labour of each prisoner during 7½ hours is equal to raising no less than 175lb. one foot high per second. In these calculations, we have assumed as before the average weight of the human body at 150lb. The height of the steps in prison tread-wheels varies from 7 to 12 inches, and the number of steps per minute from 36 to 168, which latter number is made by the prisoners of Montgomery gaol, where the height of each step is 7½ inches, and where consequently it would appear that the rate of travelling falls little short of a complete gallop, as each man has to make nearly 3 steps per second. A tread-wheel has been used as the moving power in some of the earliest pile engines, with only this difference,—that the men worked inside the wheel, instead of treading on boards projecting from the outer periphery; and the employment of the modern wheel for this kind of work, appears, from what has been already stated, to be not altogether unworthy of attention in pile-driving machinery.

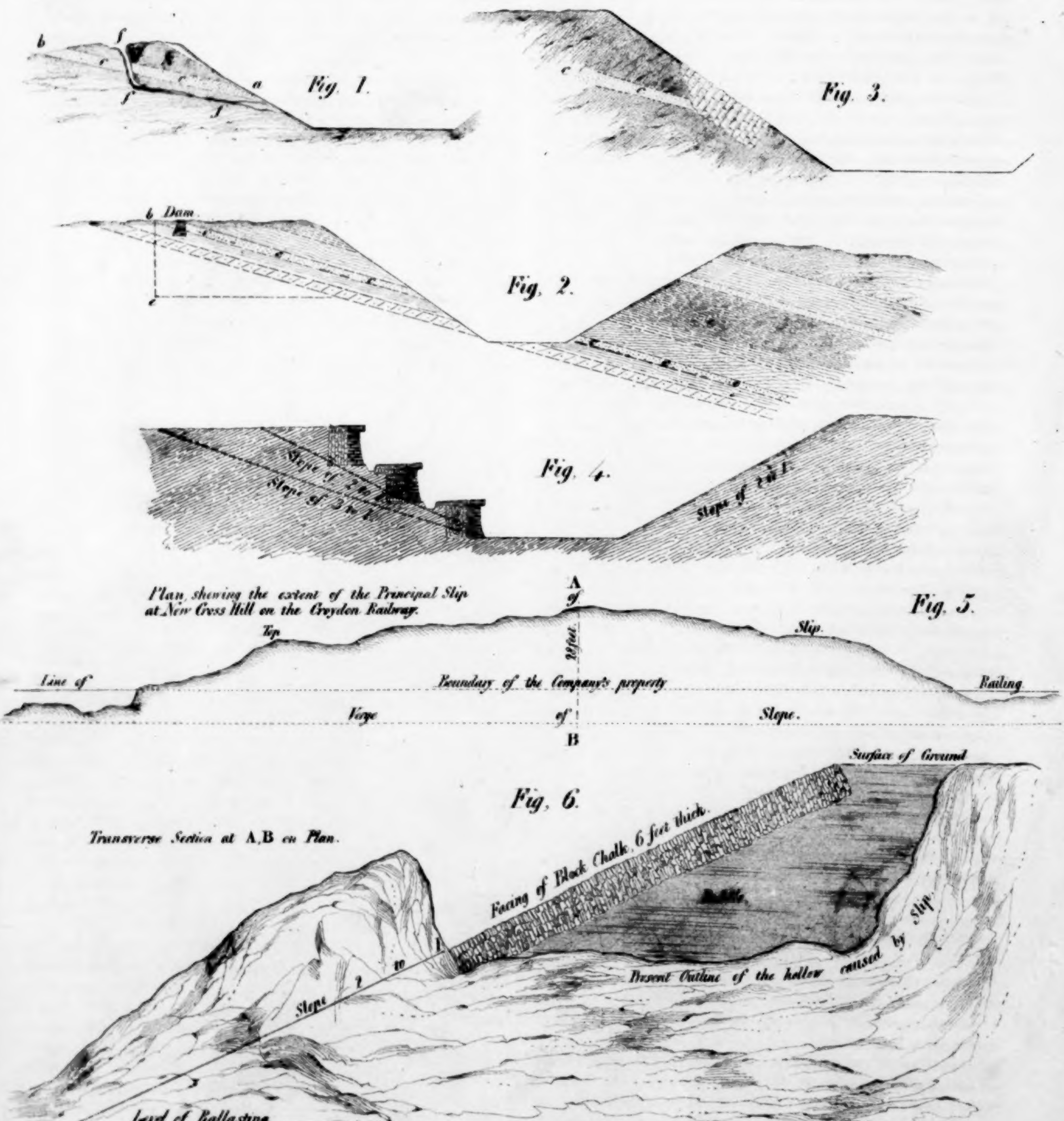
It will be unnecessary to describe particularly the modern pile engines, in which the power for raising the ram is commonly a crab of the same construction as that used for raising heavy weights. The crab is worked by two or more men, and the height from which the ram is made to fall in some of these engines is equal to 40 feet. The force of the blow thus given is of course very much greater than by the ringing engine, but the blows are at the same time much less frequent, and the force of the blow only increases as the square root of the height, so that, for instance, while a ram falling through four feet will strike the pile with a force equal to sixteen times its weight, the same ram falling through 40 feet will strike the pile with a force equal to 51 times its weight.

It follows from a comparison of the two kinds of engine in this and other particulars, that the selection in modern practice has not always been made in favour of the crab engine, but was determined by the nature of the ground to be driven into. For instance, if the material were a soft clay or loam, the rapid succession of blows effected by the ringing engine answered every purpose required, without bringing into operation the more formidable weight of the ram raised by machinery. On the other hand, in driving into very hard, stiff, retentive ground, the small weight of the monkey was almost ineffective, and the tedious slowness of the blows given by the ram was necessarily endured, on account of the compensating effect produced by its greater weight.

THE AMERICAN PILE-ENGINE IMPORTED INTO THIS COUNTRY BY COLONEL COWDIN.

In this pile-driver a steam engine is applied to raise the weight, the one which is now at work, driving the piles for the southern abutment of the New Hungerford Bridge, being of 10-horse power, and working two rams of 16 cwt. each. The frames in which the rams work are fixed at the ordinary gauge of the American railways, namely, 6 feet from centre to centre, the principal object to which these engines have been applied in America, being that of driving piles for the foundation of railways over morasses and other

RAILWAY CUTTINGS & SLIPS.



London, Published by John Weale, 59 High Holborn.

districts of country which require the line to be raised above the surface of the ground. The machine is built on a platform mounted on rollers or wheels supporting the steam-engine. It drives two piles at once, and saws off the head wih a circular saw placed underneath the platform, and also worked by the steam engine. The machine is locomotive, having the power of travelling onward over the road made by itself. With seven men it will drive in one day from 50 to 75 piles, according to the soil, from 15 to 20 feet into the ground, a performance which far exceeds that of any pile-drivers ever used in this country.

The contrivance for disengaging the ram from the follower is precisely similar to that which we have already described in speaking of Vauloüe's engine.

The importance of the steam pile-driver in the construction of railways, coffer-dams, foundations for bridges, buildings, embankments, fortifications, and other works, is strongly insisted on by the patentee.

It is calculated by Colonel Cowdin that this application of steam to the work of driving piles will effect a saving of two-thirds in the cost of driving, and that the work will be performed in one-eighth of the time at present occupied. In such a country as America, where timber is abundant, and labour very expensive, great advantages must have been experienced from the use of this machine in carrying their railways over those extensive swamps, where it would be an absurd and fanciful chimera to think of constructing solid embankments.

The system of alternate cuttings and embankments presented by the section of most of the railways in Great Britain, scarcely exhibits a single feature in common with the not less gigantic enterprises of the new world, where plains of almost interminable extent give way to mountain ranges of such enormous magnitude, as to throw their Lilliputian representatives in the British Islands into utter insignificance in the scale of comparison.

The railways of America float upon the mighty swamps which they traverse. These great diluvial deposits constitute in fact a fluid mass of great density, which affords, in consequence, a considerable capacity of flotation to bodies resting on it. Without the use of piles to an extent little apprehended by those who are unaccustomed to consider a country where timber is a positive nuisance, and constitutes the greatest obstruction to cultivation which its natural condition presents, it would be difficult to obtain a base capable of supporting a railway above the surface of the ground.

We are not aware that the use of this machine would have realized any important results, either in economy of time or money, even if it had been brought into action in the progress of our great lines of railway, because the pile-driving on these works has been principally confined to the foundations of bridges and viaducts, and has not been usually of sufficient extent to call for the employment of a machine necessarily cumbrous and expensive. At the same time, it is certain that, if either in this country or the continent it should be be necessary to drive long continuous lines of piles, whether for the foundation of railways or other purposes, the steam pile-driver must be preferable to the ordinary machines, and that in proportion as labour is expensive in the district where its application is contemplated.

The spirit of enterprize in favour of public works may again revive ere long in England itself, for, notwithstanding the great absorption of capital which the railways have effected, this country is still probably destined to be the theatre of many great engineering works, such as the drainage of lands, on a more extensive scale than has hitherto been attempted, and the recovery of lands, by embankment against the sea. Works of this nature will afford a vast amount of employment for pile-driving machinery, and whenever this employment shall be called for, Colonel Cowdin's pile-driver will undoubtedly meet with the success which the invention deserves.

At the present time a veil hangs over the engineering prospects of this country, lately so rife with innumerable projects for its internal improvement, and to the engineers themselves we must look, in a great measure, for the exertion of their united energies to effect its removal, in order to which they must act up to the spirit of their high calling, considering that the political necessities which called their profession into existence were of a nature far too lofty to limit their occupations to those of petty peddling mechanics, or to chain down their energies to the study of local trivialities, unworthy alike of their genius and acquirements.

Every walk in art and science leads to the high road which the engineer has to follow. His business is to deal with, and to control, all the elements and all the powers of nature, to bend and convert their giant forces to the use and convenience of mankind; and in addition to this honourable responsibility, his name proclaims him not *engineer*, an engine man, a maker of engines, - but *ingenieur*, an ingenious man—on the most extended scale, an inventor.

H.

ON THE CAUSES AND PREVENTION OF SLIPS OR FALLS OF EARTH FROM THE SLOPES OF CUTTINGS.

The operations of nature in effecting the undermining and destruction of cliffs, afford frequent and highly instructive examples of the agency by which falls of earth are occasioned. It would fill a considerable volume to give anything like a complete catalogue of the numberless examples of natural slips either now constantly taking place, or which, happening at former periods, have produced new lands on a lower level than the ancient surface. The public has recently been made familiar with remarkable falls of earth from the cliffs of the lias formation at Lyme Regis, and from those of the chalk of Shakespeare's Cliff, near Dover. The great alluvial tract called Romney Marsh, comprising an extent of many thousand acres, has been entirely derived from the destruction of the high cliffs, consisting of numerous strata of sand, clay, and indurated sand, which form the southern outline of the forest strata, composing the Wealden country of Kent and Sussex. All along the southern coast to the east of Hastings, an enormous destruction of the cliffs is at this time going on; numerous undercliffs are in course of formation by the constant falling of the higher lands, and it is no uncommon thing to witness a recent fall of earth, consisting of some hundred thousand tons of earth, which has been brought down by the agency of an insignificant rill of water. The northern frontier of the Isle of Sheppey presents to the sea cliffs of the London clay, which are frequently brought down to the extent of several acres in one fall. Hordwell cliff, on the coast of Hampshire, is 150 feet in height, and a mile and a half in length; it consists of strata of sand and clay, through the porous beds of which flow numerous land springs, which are constantly bringing down large falls from the cliffs.

There is a distinction, however, to be drawn between the destruction of cliffs by the sea, when the process is that of undermining effected by the waves, and when the same effect is produced by water penetrating from behind. The former case, namely, that of the sea destroying by its action in front, can never happen in the works of railways: it is only the latter which has to be guarded against.

It is very common, in speculating on the destruction of cliffs which front the sea, to confound the one cause with the other, and we are of opinion, that effects which are due to the action of water percolating from the land side, are often attributed to the action of the sea in front. One thing is certain; where the cliffs stand back some distance from the sea, and a beach dry, even at high water, intervenes between the sea and the base of the cliff, as along great part of the Sussex coast, and in many places in England, where the lias rises into high cliffs, that the sole agent must be the water of land springs; a fact, indeed, which will be abundantly evident to every one who may undertake to investigate the phenomena of their destruction.

The great mass of strata composing the crust of the earth may be resolved into the general heads of sands, clays, and limestones. The clays embrace every variety, from the most indurated binds which form slates, to the softest clays of the potter, and the argillaceous marls used in agriculture. The sands embrace every variety, from the most indurated sandstones, such as the millstone grits and the micaceous sandstones of the coal fields, ranging through the more or less calcareous sands and sandstones of the oolitic series, down to the most loose and friable sands of the London clay and other tertiary strata. The limestones again embrace every variety, from the primitive masses of Snowdon and other mountainous regions, ranging through the carboniferous series down to the chalk and the softest calcareous marls.

It will at once be evident, that to travel through the peculiar features presented by cuttings through the immense variety of strata to which this assemblage of rocks has given rise, would far exceed the limits of this inquiry, and we shall therefore confine our attention to the very important case of cuttings in clay; a material which presents to the engineer more uncertainty and difficulty, and requires in consequence more of his judgment and experience, than all other kinds of cutting together.

We shall not here attempt anything like a geological classification of clay cuttings, but it may be observed, that almost all geological formations comprise strata of clay, which the engineer may have occasion to penetrate in carrying on the works of railways and canals, and even of common roads. The clay-slate districts and the transition series contain many varieties of clay, sometimes assuming the harder form of slate, and sometimes differing little in appearance from the common tertiary clays. In the oolitic series, the clay strata rank as considerable members; such are the Oxford clay and the weald clay of Kent and Sussex.

In the green-sand formation the gault clay is a well known brick earth, whilst above the chalk the tertiary clays of the London and Hampshire basins are familiar to all the engineers of this country. Two of the principal forms under which strata of clay present themselves are, first, that of shales, and second, that of beds of variable thickness alternating with beds of sand. We are at a loss to know which of these deserves to rank foremost in point of treachery and uncertainty, for all experience goes to prove that no dependence whatever is to be placed either upon the apparently firm or really tenacious character of the clays, which enables them for a short time to stand quite perpendicular, but which is soon found to have been so completely deceptive, that slip follows slip in rapid succescession till the whole face of the cutting is broken up. We may, however, consider them in the order we have commenced with, and first, then, of the shaly clays. These are not confined entirely to the older formations, since they prevail very extensively in the coal measures, the lias, and the oolites; and even the gault of the green sand is so remarkably shaly at some places, (Dorking, Surrey, and Pulborough, Sussex) as to be readily confounded with the coal shales. These shales are always highly laminated, commonly loose and crumbling in their stratification, sometimes remarkably dry and brittle, and at other times completely saturated, and emitting water from every pore and crevice of their mass. However dry these shales may appear on cutting through them, they are never to be trusted, because it is certain that whenever water finds its way into them, its effects are most destructive.

In addition to the ordinary consequences of water penetrating them at a greater or less distance from the slope, there is another action of this potent element which is scarcely less dangerous in the case of these shales. When their section is left exposed on the face of the slope they readily imbibe all the moisture which falls upon them in the form of rain and snow, and the process of destruction thereupon immediately commences something in the following manner. The rains wash out of the crevices and hollows of the stratification numerous particles, which the water will either dissolve or hold in suspension, and then the natural hollows and porosity are somewhat increased. Dry weather or winds probably succeed the rains, and many loosened particles are converted into dust and borne away. Slight diminutive falls now take place on the slope, but these are at first so small as to be scarcely perceptible; they are, in fact, the roofs of the minute caverns which have been already formed; by the succession of atmospheric changes these caverns are greatly enlarged, and the whole action is much extended, until at length a considerable part of the slope is undermined, and a serious fall takes place, simply because the support of a heavy mass has at last been entirely carried away. All this, we are to observe, has been effected without water from behind; and as this mode of action, where it either exists or is apprehended, should give rise to an entirely different treatment by the engineer in dressing the slopes, it is important to distinguish between the two kinds of destruction.

Where water penetrates from behind, it soaks into the surface through some porous or permeable stratum which admits of its percolation, and although solid clay, even without puddling, is a tolerably water-tight material, yet most of these shales are so loosely laminated, or contain so much sand in the partings or seams of the laminæ, that water will find its way between them without much interruption. When the water has once arrived at the slope, the supply of moisture from behind being tolerably constant, its *modus operandi* is not difficult to trace. Minute particles, as before, are at first washed out. Warm weather dries the sides of the pores into dust; winds, rain, and hail storms carry out the dust, and even larger particles; larger hollows in time are formed, the tendency of every natural phenomenon being to increase and not to retard the destroying process, till at last serious falls begin to take place, and then people begin to exclaim, for the first time perhaps, that the slope was not sufficiently flat. Nothing can be more senseless than this exclamation, and nothing is more calculated to inspire the profession with contempt for public opinion, when they hear it so

absurdly expressed on subjects which the public cannot possibly understand. Witness the recent accident in the Sunning Hill cutting on the Great Western Railway. Almost before the bodies of the unfortunate sufferers were cold in the sleep of death, a multitude of scribblers are turning the accident to account, and are busily engaged in electrifying the public by a display of their engineering knowledge. One blockhead enlightens us, though the columns of "The Times," with his sapient observations on the sand of Hampstead Heath, from observation of which he concludes that the slopes of the Sunning cutting were far too steep. Another dunce takes several days to mature his lucubrations, and when they come forth they are made up of some unintelligible jargon about centres of gravity, which the writer thinks so important, that, "if excavators (to use his own words) knew how to find the centre of gravity of clay, the slopes would be made to stand," &c. As far as we can discover, not one of the crew, who thus delight in exposing their ignorance and folly to public ridicule, has ever hinted at the true cause of that slip, or ever seemed to imagine that any thing could possibly have been to blame but the steepness of the slope.

It would be absurd to argue with such men; it would be absurd to tell them that the slope of two to one is amply sufficient, and it would be wasting time and breath to point out to them the case of Highgate-hill, where the slopes at this very hour are six or seven to one, and where they are even now slipping. We shall return to this when we come to consider the expedients to be attended to, in addition to the mere sloping, in order to effect the security of earthworks; but, in the mean time, we cannot help inquiring, though without hope of arriving at a satisfactory conclusion, by what singular accident it is that every smatterer in science, ay, and many a one to whom science is a sealed book, considers himself perfectly qualified to pronounce on engineering considerations, and undertakes, without the least hesitation or feeling of incapacity, the province of determining and deciding on points which even engineers themselves—the wisest and most accomplished of the body—deem of the highest moment, and deem capable of solution only on the authority of great acquirements and long experience.

There is in the metropolis a certain publisher of engineering works, who advertises them for the use of engineers, students, amateurs, &c., as if there *could* be amateurs in engineering! What can the man mean? What kind of a genius, we wonder, is an amateur engineer? We suppose the correspondents of "The Times"—those great authorities who so mercilessly launch their thunders on the devoted head of Mr Brunel—are amateur engineers; and if they are fair specimens of the genus, we heartily wish they were preserved and ticketed, for the admiration of posterity, in the British Museum, or some other great depository for curiosities, from which they would no more emerge to plague and disgust the living world.

It is well enough for the fine arts; it is well enough for professions which depend on the caprice of the great, to have their patrons and amateurs; but the science of the engineer is based upon the wants and necessities of civilized society, is beyond all caprice, desires no patronage, and recognizes no amateurs. Dr. Lardner, writing in a contemporary journal under the signature of Z., expresses a wish that Dr. Lardner may shortly return to this country, in order to destroy the swarms of vermin with which the track of practical philosophy is now overrun. This end, that is, the destruction spoken of, may be desirable enough, but whether the modest and learned Doctor be the most qualified person in the world to achieve it, is a question we shall not at present enter upon, but leave to the judgment of that part of the public—and it is fortutunately not an inconsiderable part—who have enjoyed the opportunity of understanding the Doctor's character and acquirements.

The effect of frost on the slopes of cuttings having been occasionally misunderstood, it may be useful to glance at what appears to be the true nature of its operation. It is the more necessary to understand this correctly, because it is undoubtedly certain, that, while the period of slipping is usually accelerated by frost, the dry appearance of the frozen surface of the slope often disarms the suspicion of danger. This was what deceived the foremen appointed to inspect the slopes of the Sunning cutting, one of whom, named Bottrell, in his evidence at the inquest on the body of Richard Woolley, was asked the following question:—"Is it not more likely that slips will take place after a frost preceded by heavy rains?" to which he made the following answer, "No, cos the wet was dried out on it by the frost. When I drained it I didn't see any danger whatever, and so I didn't keep the watchmen on." It is obvious here how completely this man was deceived; for at the very time when he thought the water was dried out of the slope, the mischief was brewing just below the surface, and as soon as the frost broke up, or even relaxed in its severity, the slip immediately took place. The Sunning cutting consists of nearly horizontal strata of sand and clay alternating with each other, and through the permeable beds percolates a certain quantity of water, which is received into them somewhere on the surface of the ground, at a greater or less distance from the top of the slope, and of course in a greater quantity than usual after heavy rains. When this water reaches the slope, if nothing prevents its escape, the consequences take place which we have described above; but if any thing obstructs the trickling out of the water, the particles acted on by the water, and carried by it either in solution or in mechanical suspension, are accumulated beneath the frozen face of the slope, where the closeness and solidity of the stuff are increased by the infusion of the particles transported by the water. This pressure continues until either the frost gives way, or until the pressure itself becomes sufficient to break through the frozen surface, when a hollow is immediately formed, and a portion of the previously incumbent earth, being left without support, immediately falls. Whether the slip thus occasioned be considerable or not, depends upon the extent of the hollow suddenly formed by the breaking out of the interior stuff; but in either case, we hold it to be an error that slips so occasioned take place without warning. We consider the strata themselves, by their very disposition and structure, afford a warning; the frost accumulates the evidences of danger, and, in most cases, previous swelling on the surface of the slope clearly points out the coming danger in a voice of warning which cannot be mistaken.

In the preceding explanation of the effects produced by frost, we have entirely omitted to notice the ordinary expansion of water when frozen, which it is well known often occasions the bursting of large and hard stones, and which it might be supposed would act with considerable effect in bringing down falls of earth by heaving masses from their natural bed, and allowing them, when thus loosened, to slip into the cuttings. We are aware that this action of frost upon the slopes of earthwork is maintained by some to be the most important and dangerous which has to be guarded against; but after some consideration on the subject, our judgment, based upon many observations made upon falls of earth in a great variety

of situations, decidedly is, that, in the case of earth-work slips, frost does not perform the part thus attributed to it. It is true that, where natural fissures or considerable natural cavities exist, the frost may follow the water so as to freeze it, and occasion its expansion, under which circumstances it may cause a bursting of the material which surrounds it; but we are persuaded that, in the case of ordinary cuttings, the severest frost does not penetrate more than eight or ten inches into the ground, so that the water below this level is beyond its influence, and not subject to the expansion which its congelation occasions. We are of opinion, therefore, that the action of frost within or beneath the mass of the slip, is not sufficient to dislodge it from its bed; and, in addition to what has been said about the penetration of the frost, it may be remarked that the slips seldom take place during the frost, as they would do if produced by frozen water beneath them, but immediately after the frost, as might naturally be expected from the true effect produced by the frost, as first explained.

Fig. 1 *(see the plate)* explains an effect of frost, to which we are inclined, however, to attribute some consequence. Let *c c* be a porous bed of sand or gravel, which is acted on by water penetrating at the surface *b*, so as to become loosened and hollowed at *a*. Then the pressure of the incumbent mass A, squeezes out more of the stuff from *c*, till at length A is partly undermined, and slightly falls towards *a*,—thus a fissure is formed at *f*. Now, however small this fissure may be, it is evident that water becoming frozen in it, will exert an enormous pressure against the mass A, which will therefore most likely be dislodged along the line *f f f*. Many slips have happened in this way.

It is now time to recur to the different mode of treatment to which the finished surface of the slope should be subjected, according as the cutting is originally wet, or free from moisture. It is usual, without regard to these very different circumstances, either to soil the slopes of deep cuttings, or to face them with greensward turfs. Where the slopes are soiled with vegetable mould, they are usually sown with rye grass and clover seeds, the object sought in either case being to protect the face of the slope from the external action of the atmosphere, from frost, rain, &c. Now, where the strata intersected by the cutting are found perfectly dry, and where there is no reason to apprehend the penetration of water from behind at any future time, we are strong advocates for the practice of protecting the slopes either by soiling or turfing, because this expedient will prevent the only injury to be apprehended in such a case, namely, that which might arise from external causes acting on the face of the slope. But, on the other hand, when the strata contain water, or even when it is at all likely, from the alteration of watercourses, or from any changes which may take place on the surface of the adjacent lands, that, during heavy rains, or at any other time, water may penetrate from behind, and reach the surface of the slope, then, in all such cases, a more dangerous or injudicious expedient than turfing cannot possibly be adopted, and the following is our reason for thinking so.

Referring to what has before been said on the action of water penetrating behind the slope, and carrying out minute particles as the first part of the destructive process, it is obvious that this must for a time be impeded where the surface of the slope is covered with turf. Thus an effect analogous to that of frost is produced by any artificial covering of the slope; an accumulation takes place behind this covering, and exerts a pressure which in time bursts suddenly through it, and then down comes a considerable fall. Hence this very important objection to artificially covering the slopes, that the incipient action of water from behind is concealed from observation, and is probably only observed just before the slip is about to take place. It is true that a heaving of the surface where it is turfed is usually produced before the confined stuff breaks out, and this, if closely observed, ought to afford sufficient indication of the coming danger; but this appearance, as in those cases where the ground is disturbed during frost, may frequently, and no doubt is frequently, overlooked, and disastrous consequences ensue from the negligence.

The New Cross cutting on the Croydon Railway had its slopes on both sides turfed, and presented, when finished, a very handsome appearance: at this time, also, there was no appearance of water, the cutting, when finished, being remarkably dry. It happened, however, that, more than twelve months after the completion of the cutting, a bed of sand, which had hitherto been dry, was penetrated by water, which shortly converted it into a running or quicksand, and eventually brought down lately some very extensive slips. It can scarcely be said that any error of judgment was displayed in covering the slopes of this cutting, for probably there never was a work which reflected more credit on the engineer than this cutting, and probably every engineer of the day would have considered the slopes safe, and calculating on their remaining dry, would have followed Mr. Gibbs' example of covering them; yet, having added somewhat to our stock of experience, let us here derive a lesson which may prove useful in future, and determine to investigate well the possibility of the slopes ever being subjected to the power of water from behind, before we adopt the practice of soiling or turfing them. Had the slopes of the New Cross cutting not been turfed, it is probable that the interior disarrangement would have been observed on the surface of the slope, and proper precautions taken to prevent the slip, or at any rate to prevent mischief happening from its fall. In all cases where existing slopes are artificially covered, and particularly where the surface is much concealed by vegetable growth, we would recommend the most watchful attention, in order that the slightest heaving or swelling of the slope may be observed and acted upon. The practice of soiling the slopes with a few inches of vegetable mould, does not appear so objectionable as that of turfing, because a very slight pressure will break through the loose soil or mould, and the danger will be at once perceived.

In entering upon the second principal division of clay cuttings, namely, those where the beds are not shaly, and where they alternate with beds of sand, it will be observed that the explanatory part relating to the action of water attacking the slope, both in rear and in front, must necessarily have been somewhat anticipated in speaking of the shaly clays. The mode of destruction is nearly similar in both kinds of clay, the principal difference being, that where there are distinct beds of sand, they are in many instances extensively converted into quicksands, and run out from their natural position more suddenly than a more clayey material. It may thus be laid down as a general principle, that slopes, consisting of alternate layers of clay and sand, are subject alike to more rapid and more extensive destruction than those of shaly clays, the same causes of destruction operating in both cases. To slopes where sand and clay alternate, also, we would apply the same remarks which have already been made with respect to frost, and to the covering of the slopes with turf.

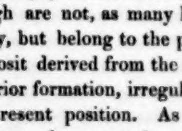
From the example afforded by the New Cross cutting, where, as

far as we are aware, there is only a single stratum of sand with a considerable depth of clay above it and beneath, we should be inclined, wherever sand appears intermixed with beds of clay, to leave the sandy part of the slope uncovered, however dry it may appear during the execution of the work. It is remarkable that the New Cross and the Sunning Hill cuttings are both in the plastic clay; the latter, however, is much more arenaceous in its character than the former, and appears, from the evidence of Mr. Brunel, to have contained a bed of stone near the top. In the New Cross cutting there was no appearance of stone, with the exception, perhaps, of a few septaria, which belonged to the overlying London clay. The depth of this cutting exceeds 80 feet in the deepest part, and the slopes are two to one; that of the Sunning cutting is 57 feet deep where the recent slip took place, the slopes also two to one.

In some strata, the sandy material is very confusedly mixed with the clay, and this confusion probably gives rise to the most difficult cases, because it is almost impossible to predict the precise parts of the slope where danger is most to be guarded against. In regular strata, this disposition is not so common as in the diluvial deposits which cover so many of the more ancient strata, although it may be observed in many of the latter, as in the lias and the Wealden strata of the south-east of England. The most remarkable and probably well-known instance which could be referred to as an example of the trouble and difficulty occasioned by a confusedly mixed assemblage of sandy and clayey strata, is that of Highgate Hill, where the beds cut through are not, as many have supposed, those of the true London clay, but belong to the post-tertiary class, being clearly a diluvial deposit derived from the arenaceous and argillaceous beds of the inferior formation, irregularly mixed together, and washed into their present position. As this cutting has excited much interest, and been often quoted, sometimes in support of opposite doctrines (see the evidence of engineers before Parliament, on Railway Bills,) the following observations made on the spot may not be entirely useless. They are extracts from a larger body of notes made nearly four years since, but we are not aware that from that time to this any alteration has taken place in the state of the slopes.

"On the London side of the archway, and on the Hampstead side of the road measured, the slope of the earth adjoins the wing-walls and abutments of the archway. The slope does not continue down to the road, but terminates at the top of a retaining wall, about 15 feet high, and gradually diminishing in height as it recedes from the archway. This part of the slope was 33 feet perpendicular height, and 57 feet horizontal length, giving a slope of nearly 2 to 1. The material composing this slope appears to be clay of a sandy, loamy description, and the face of the slope is very much broken. The corresponding slope on the other side of the road appears to be about the same inclination as the above, but it cannot conveniently be measured, being inclosed by a fence, and forming part of a garden ground. The remainder of the slope also on the Muswell Hill side of the road is so irregular, that it could not be measured without the aid of a level. On a part of this slope, about 15 feet above the road, is a flat place, of which fig. 7 is a section—and here, in the flat part A, is a quantity of stagnant water, of no considerable depth, but probably arising from the pressure of water on a higher level, otherwise it would scarcely be found in this position at a dry time like the present.* It is probably this water which has deranged the slope to such an extent, and from which has arisen so much difficulty in the execution of the work.

Fig. 7.



"On the same slope, about 100 feet nearer London than the place A, is an old well, which has been bricked all round, but only about half the bricking now remains. What depth it may have been is not known. The bottom is now composed of mud; the depth of the water not more than two feet; the diameter about four feet: the water is of very bad quality.

"Some excavation is now in progress at this part of the slope, the intention seeming to be that of effecting the drainage of the slope, and for that purpose small channels are made, along which the water runs into a well, somewhat larger than the other, and nearer the bottom of the slope. This well is bricked nearly all round, and from it a small trunk appears to convey the water under the road, but what becomes of it afterwards cannot be ascertained, the ground being enclosed. This well is about 6 feet in diameter. It is possible that along the road towards London there may be side drains, into which the water is diverted from the slopes; and along these drains the water would certainly run freely off, as the road has a considerable fall in that direction. There is no appearance of the drains to be seen, however, and if they exist they are covered up. This slope is everywhere full of water. The places shown by fig. 7, and of which there are several, appear to have been formed artificially. In these places the water stagnates in a pool, which is commonly about a foot in depth. It seems clear that, except for the expedients which are adopted in the first place to collect and then to carry off the water in small channels, the action of this element would still further destroy the slopes, and continue to bring down the stuff into the road. It is necessary, however, to observe, that the method of draining which is adopted appears to be very imperfect; nor is it perhaps easy to suggest an expedient which would prove entirely effectual. A longitudinal channel, having considerable fall towards London, has been already cut along the face of the slope; this channel is two to three feet deep, and about a foot or eighteen inches wide, the sides supported by cross timbers; but it does not appear to have effected much good. There is at present no water in it. Some parts of this slope have an extremely flat inclination: it seems to have been cut back into the adjacent land at several different times, and no doubt at vast expense. It is, upon the whole, too irregular to measure with accuracy, but it is certainly not less than 6 or 7 to 1 from a point about 100 feet south of the archway to the end of the cutting, going towards London. The first 100 feet mentioned above may average something flatter than 2 to 1. The slope, as already described, where it adjoins the archway, is about 1½ to 1, but it immediately becomes flatter. All the soil cut open and exposed on this side is a description of very sandy clay, without tenacity or adhesion, capable of absorbing much water—general colour, yellow and yellowish brown: it contains commonly white spots of sand, and the water which issues from it is highly coloured by the oxide of iron. The slope on the west or Hanpstead side of the road appears to be mere regular than the other, but is also extremely flat, particularly the part which is farthest from the archway. On this slope is also a well, about six feet diameter, with a channel down the slope draining into the well. Close to the arch the slope is about 1½ to 1,

* The writer has observed pools of stagnant water like the above on the slopes of cuttings through the forest strata in the south of England.

but it gradually becomes flatter. On the Barnet side of the archway considerable quantities of bricks are made: the clay is of the same loamy, sandy nature, of a yellowish colour; and a good deal of water occurs here also."

The preceding account will afford some idea of the vast trouble and expense which must have been occasioned by the slopes of this cutting, and in a case of so much complication it would be rash to hazard an opinion as to the mode of drainage which it would be most proper to adopt. The irregular mingling of the sand and clay renders it hopeless to attempt cutting off the supply of land water from behind. The cutting through Highgate-hill in fact is distinguished from most others by the occurrence of the sand and clay, not in beds or strata of the least regularity, but in patches and pot-holes, so that it is almost impossible to trace the course of any particular bed which is intersected by the slope, to the place where it crops out on the surface of the land above. Hence, it is in vain to seek on the surface for the places where the water first penetrates, and from which it eventually reaches the slope; and consequently the measures adopted to secure the stability of the slope must be confined to the surface of the slope itself.

We are not aware whether the wells which have been spoken of were sunk with the view of reaching some permeable stratum, which would carry off the water held by the wells to a lower level, and thus serve to drain the slope, or whether they were simply intended to act as reservoirs, from which the water was to be conveyed by the channels made in the slope. The former of these objects, if ever intended, the wells have certainly not achieved; but the idea which they furnish may nevertheless be serviceable in other situations where the disposition of the strata is favourable to this plan of drainage. We have indeed heard of instances, unconnected with the management of slopes, where a highly successful result has been attained in the way of drainage, by sinking through the water to be carried off down to a stratum of sand or gravel, which, passing to a lower level, and not being itself charged with water, would convey the water from the well. In attempting a plan of this kind, however, it is important to be certain that the stratum intended as the medium for carrying off the water does not itself receive water from the surface at a higher level than the bottom of the well, because in that case the water of the well will only sink down to the level at which the permeable stratum receives its water at the surface; and, worse than this, it should be borne in mind that if the source of the water in the pervious stratum be higher than the standing depth of water in the well, that water, instead of being drawn off, will be raised to a greater height, and a directly opposite effect produced to what was intended.

In proceeding to consider expedients for the prevention of slips, it will be natural, first, to inquire what are the plans which have hitherto been adopted to secure the slopes of railways and canals; because, if we can ascertain the circumstances under which any particular expedients have been followed, and the success which has attended them, we shall be able to appreciate their value, and to judge of their efficiency in those numerous cases of slipping which are now likely to occur in the works of railways. It is peculiarly unfortunate, however, that there is scarcely, throughout all the great earth-works of this country, a single trace of that valuable kind of experience to be met with. The subject of securing slopes from slipping has very seldom been systematically considered, nor has its importance ever been sufficiently recognized, until the occurrence of some large slip has painfully awakened the attention of the engineer. It has then been usual to secure the slope in a temporary fashion by driving piles, or picketing it with faggots, and then, after it had been left open some time to drain, it was usually cut back at a flatter inclination than at first. It is evident that this proceeding is quite inefficient as a permanent remedy, and we shall therefore attempt to establish a general class of expedients, which we shall first apply to the prevention of slips in cuttings where they have not hitherto occurred.

In some situations where the strata are tolerably regular, it is possible to trace on the surface of the slope a series of distinct beds, which will admit of or resist the penetration of water, according as they are more or less arenaceous in their character. Most engineers who have the good fortune to have been concerned in canal works, where the subject of puddling, and of the capacity of different stuffs for retaining water, is of the greatest importance, will be perfectly able to decide on this particular character of the beds appearing on the slope. With respect to other members of the profession who have sprung up like mushrooms during the progress of railways, and who can date their ephemeral existence no further back than the origin of this new class of works, we trust, after all the experience we have now had of the mischiefs inflicted by such raw and inexperienced hands, that we shall offend in no respect the more sensible and cool-judging of the profession, by asserting openly that such men ought never to have been intrusted with the execution of railway works, because, simple as these commonly are, there may yet be cases where all the skill of the most experienced canal engineers will be required. The recent and the future cases (for there will yet be many) of instability in the slopes of cuttings, are of this kind, for there is probably no branch of engineering which requires more practical skill, or more acquaintance with geology and other physical sciences, than that of constructing and disposing in a substantial manner large masses of earth-work. In proposing, therefore, to the engineer to trace out and make himself thoroughly master of the constituent qualities of the separate strata intersected by the cutting, we suppose him sufficiently skilled in geology, and its applications to engineering, to be able to decide with tolerably correct judgment on points of this nature. Wherever, in his examination of the slope, beds of sand or gravel are met with, however thin they may be, danger from undermining is always to be apprehended. The dip of these beds across the railway should therefore be ascertained: this may usually be done, when the stratification is regular, by indentifying them with the corresponding beds on the other side of the cutting, and some clue will thus be afforded as to the line at which these beds crop out on the surface above. It is true that the indication thus afforded is often very deceptive, because a change may have taken place in the inclination of the strata which cannot be observed, and thus all attempts to discover the precise outcrop may become utterly fruitless. Suppose, however, as in fig. 2, the sandy bed *c* to be observed on both sides of the cutting, and supposing its dip to be uniform, it may then be ascertained where it will crop out on the surface, as at *b*. Now, it is from the water penetrating at *b* that the principal danger will arise, and it seldom happens that any considerable slip takes place on the opposite side of the slope, as the water on that side can only reach the bed *c* by penetrating at the slope itself, and the inclination of the stratum will carry the water away from instead of towards the slope, as on the other side. It is evident, therefore, that the object to be effected is that of preventing the water

penetrating at *b*, from reaching the slope at *a*. For this purpose two expedients present themselves, namely, the construction of a puddle dam at *b* or at *a*. We are in favour of the dam at *b*, as shown in fig. 2, because the water will then not sink at all into the stratum *c*, but flow over the surface of the ground till it finds some more permeable stratum to penetrate. But if the protection be constructed at *a*, it would have to support the weight of the column of water and loosened sand, equal in weight to *b c*, and this pressure upon it may cause it to give way *en masse*, or may by degrees act upon it so as to dissolve and penetrate the puddle, and effect the undermining of the slope. Hence, wherever it is practicable to find the outcrop, there the puddle-dam ought to be constructed. The size of this work will of course depend upon the depth and dip of the bed of sand; for cutting off the water from a bed 2 feet in thickness, a dam of about 2 yds. × 1½ yds. or 3 cube yards of puddle per yard lineal will commonly be sufficient. This puddle should be extended longitudinally as far as the dangerous stratum *c* makes its appearance on the slope, and where it is at once effected as a part of the original work, its cost will be quite inconsiderable, namely, not more than three shillings per lineal yard. The principle of prevention here indicated is of general application in all cases where the water-bearing stratum can be traced from the face of the slope to its outcrop on the surface of the ground above. There may be several strata which admit of the penetration of water, intersected by the cutting, and it will of course be necessary if possible to discover the outcrop of all these strata, and cut them off by separate puddle dams. There may also be cases where the precise line of outcrop cannot be ascertained within a breadth of 30, or even 50 yards or more; but if it be quite certain that water penetrates somewhere within a zone of 50 yards, we should recommend the trenching and puddling of the ground for the whole of this breadth, in order that the perfect security of the slopes may be effected. This puddle being a mere surface work, and not having to sustain any weight of water, need not be more than a foot in depth, and may be cheaply and expeditiously effected by excavating parallel trenches about 6 feet wide, and throwing back the surface mould from one trench on to the puddle which has been worked into the adjoining trench. The cost of this work will not exceed about four pence per square yard.

In many cases of clay cutting, however, it will be found utterly impossible to trace the water-bearing strata to the surface. This will happen whenever, as in Highgate-hill, the strata of sand and clay are so intermixed as to have no regular dip, so that they furnish no clue by which to discover their outcrop on the surface. It would obviously be an absurd and fruitless labour to probe every point of the surface above in search of sand or gravel beds which might convey water to the slope, because, however great a number of these might be discovered, their course towards the slope would still be obscure, and no preventive means of sufficient extent could be adopted to avert the mischief arising from water in a case of such complication. It is evident, therefore, that the system of treatment here must be confined to the slope. Fig. 3 shows a plan for preventing water percolating through the porous bed *cc* from injuring the slope. It consists of a protecting work of rough unhewn stones, about six feet in thickness, the stones to be pitched at right angles to the face of the slope, as shown in the sketch fig. 3. Almost any description of stone will answer for this purpose; and if rough blocks of sandstone or limestone, such as are used for building, cannot be procured, blocks of hard chalk may be placed in the work. It is evident that such a protection will cost very little in any district where stone is abundant. Even in the neighbourhood of London, where it would be cheapest to construct it of chalk, the cost of a protecting work of the extent shown in the sketch would not exceed 40*s*. per lineal yard. Where several of such porous beds as *cc* can be discovered on the face of the slope, and their outcrop on the surface cannot be traced, they may be faced with the protection of stone to a greater extent than shown in fig. 3; and even in some cases it might be necessary to face the whole slope with a work of this kind. It should be understood that in placing these stones no mortar is to be used, and any vacuities which may exist when they are placed together, will not deteriorate from the efficiency of the work, because the puddle which is to be carried up behind the wall will effectually prevent any water from reaching it.

Fig. 4 shows a plan which may be adopted in the original execution of a work, where the earth to be cut through is of an irregular character, and where the sand and clay are confusedly mixed, as in the case of Highgate-hill. The walls shown in the sketch are intended to be eight feet in height, and about three feet six inches average thickness, to be built of the same description of stone as already mentioned, and to be well puddled behind with an upright puddle, four feet in thickness. It is evident that any water falling on the benches *b b* will run into the drains, and if these have a longitudinal fall, the water will be conveyed away by them; but if these have not a fall longitudinally, the water must be conveyed through the walls down to the drains on each side of the ballasting. The sketch shows the comparative quantity of earth to be removed when the work is executed as here proposed, with walls and benches, and with a slope of 2 to 1 and 3 to 1 severally. The following estimate shows the comparative expense of executing one slope.

I. COST OF WALLS AND BENCHES.

		£	s.	d.
Building 9½ yards	at 5*s*. per yard	2	6	8
Cutting 28 yards	„ 1*s*. „	1	8	0
Puddle and drains		0	13	0
Cost per yard lineal		4	7	8

II. COST OF ONE SLOPE OF 2 TO 1.

Cutting 64 cube yards	at 1*s*. per yard	3	4	0

III. COST OF ONE SLOPE OF 3 TO 1.

Cutting 96 cube yards	at 1*s*. per yard	4	16	0

It appears then that the cost of executing the sides with walls and benches would amount to something less than that of cutting the slope at an inclination of 3 to 1. This is in a cutting of 24 feet in depth; but if we estimate on the same data for a greater depth of cutting, as, for instance, 32 feet, the saving will be greater in favour of the system of walls. Thus, a slope cut at 2 to 1 for 32 feet in depth, will cost £5 14*s*. per lineal yard; at 3 to 1 will cost £8 11*s*.; and if executed with walls and benches will only cost £6 1*s*. 5*d*.; and further, if we take a greater depth than 32 feet, we shall find that the benching and walls can be executed for less than the ground can be cut, even with a slope of 2 to 1. This arises from the fact, that when the stuff is cut with a slope, the quantity increases as the square of the depth, and of course the cost increases in the same ratio, whereas the cost of walls and benching scarcely increases in a higher ratio than directly as the depths.

With respect to the prevention of future slips, we cannot make

a better exposition of our views on this subject than by sketching briefly a design for preventing future slips at New Cross Hill, because the same system, with slight modifications, may be followed in most other cases of slipping.

Figs. 5 and 6 show a plan and section of the most recent slip at New Cross; it will be seen that the broken ground extends longitudinally for about 65 yards outside of the Company's property, and transversely or back from the slope about 28 feet in the middle of the slip. The quantity which has here fallen cannot be less than 5,000 or 6,000 cube yards. The whole of this extensive cutting, however, is in a most dangerous state, and it is imperative on the Directors of the Croydon Railway to take immediate measures for securing the whole length of the slope, even where it appears at present to be sound.

The following brief outline will explain the process which we should recommend to the Company:—

SPECIFICATION.

The whole of the stuff which has fallen from the slip is to be cleared away, and any loose stuff remaining on the face of the slip is to be brought down, and to be also completely cleared away. At the top of that part of the original slope which remains uninjured is to be laid the foundation of a wall. The wall to be carried up solid, with a puddle behind it, and the puddle is to occupy the entire space between the back of the wall and the solid ground from which the mass of the slip has fallen. The upper face of the wall is to be laid flush with the original part of the slope which remains uninjured, and to be carried up solid, with the puddle behind it, so as to form on its upper face a continued line sloping 2 to 1, fair with the before-mentioned original uninjured part of the slope, as shown in the transverse section (fig. 6). The wall to be built without mortar, to be composed of blocks of chalk from Merstham, to be sound and hard; but it is not anticipated that any dressing or scabbling will be required for these blocks, and the contractor will therefore merely reckon in his estimate the cost of procuring suitable blocks, either from the sides of the Brighton Railway at Merstham, or from the adjacent quarries, without any addition for dressing or scabbling. The stones to be laid at right angles to the face of the slip, as shown in the transverse section.

The puddle to consist of clay, mixed with such proportion of sand as the engineer shall direct, to be well worked, and carried up solid at the back of the wall, and simultaneously with the progress of the wall. The contractor may reckon on the materials for the puddle being found in the cutting.

The plan here proposed will effectually prevent any water from reaching the slope from behind, whilst any water falling on the wall itself will percolate through the stones, and being stopped by the puddle, will simply drain down to the railway ditches at the foot of the slope. It will be evident that the body of wall and puddle must be displaced before any slip could take place, and it is considered that the weight of the puddle and stones will be more than sufficient to resist the pressure which will act behind it.

The cost may be estimated as follows:—

	£	s.	d.
Getting and loading chalk at Merstham, per cube yard	0	1	6
Carriage to New Cross, by railway . .	0	2	0
Unloading and building	0	1	6
Cost of wall, per cube yard . .	0	5	0

Suppose the average height of wall and puddle to be 20 yards, then,

Wall	$20 \times 2 = 40$ yards cube at 5*s*. . .	10	0	0
Puddle	$20 \times 3 = 60$ ditto 6*d*. . .	1	10	0
	Cost of wall and puddle per yard lineal	11	10	0

The subject which has given rise to this paper is evidently of great extent, and this brief attempt will go a very small way towards exhausting it. We have, in fact, from the necessarily confined space to which we are restricted, only been able to glance at a few of the more prominent circumstances connected with slips, which pressed more immediately upon our attention: there is undoubtedly an extensive and most important field of inquiry open to the professional student and to the practising engineer. The stability of earth-work in cuttings and embankments, is a subject of deep interest to all who have embarked in railway speculations; and it behoves all who are so concerned to look so far at least after their own interests, as to satisfy themselves that proper measures are being taken on their respective railways to place the slopes in a state of security, and to maintain them afterwards in permanent and efficient repair. In conclusion, there is one thing to be said for the consolation of all whom it may concern, namely, that all future slipping *may* and *can* be prevented, if proper means be at once taken to protect the slopes; and on the other hand, be it remembered, that if precautionary measures be not adopted speedily and energetically, no one is safe in fixing limits to the extent of mischief that may ensue. We are informed that 1500 men are at this very time employed on the London and Croydon Railway, a short line of only ten miles, in repairing the slips which have taken place there. This enormous force may be required for weeks or months, at a cost to the company of not much less than £300 per day. When, in addition, we consider the loss of traffic occasioned by the notorious insecurity of the works of any railway, and the great length of time which is required to re-establish the public confidence, when it has once been shaken, there needs no argument to establish a paramount necessity for the execution of instant measures to avert such an accumulation of impending evil.

H.

PHANTASMATA;

OR,

SCENES IN THE SHADES.

Scene II.

JOHN NASH AND THEODORE HOOK.

HOOK. NASH, my old boy, I did all that I could for you. I even ventured to turn architectural critic for your sake, and protested in black and white that the time would come when Buckingham Palace would be fully appreciated—no longer scoffed at and derided as the Pitti or pitiful palace of England, but worthily admired as the great national work of the nineteenth century. (*Aside*) I might have said, as the great *John Nashional* work.

NASH. May you prove to have been a true prophet.

HOOK. Why, as to being a prophet, I won't answer for that; for I am sorry to say, that, so far from taking me as their oracle,

some folks flatly contradicted me, and declared my opinion to be nothing more than fulsome flattery.

NASH. Then I am afraid, friend Theodore, you laid it on more liberally than discreetly. Perhaps you indulged too much in the energetic George Robins's vein.

HOOK. No; I took care not to imitate the *Great Knocker-down* too closely, or I should have knocked your reputation on the head at once; at least, have smothered it, and overwhelmed both you and your work under a mountain of magniloquence. I should have lugged in the Duke of Buckingham—Queen Charlotte,—*Rus in Urbe*—royal virtues—library—Dr. Johnson, and tastè of George IV., Arch of Constantine; in short, whatever impertinent rigmarole came uppermost. No; I kept strictly to the point, confined myself to the structure itself, and bore my testimony to its surpassing merits in most critic-like fashion.

NASH. That was right. You pointed out severally, with judicious commendation, its various excellences and beauties: you dwelt with encomiastic rapture upon the magnificence of the octastyle Corinthian portico, or the simple majesty of the Doric colonnades?

HOOK. No, faith! Its merits are so surpassing, that it quite surpassed my ability to point them out. You know the old proverb, The less said, the sooner mended. Besides, I did not care to descend to particulars. (*Aside.*) Had I been in the least particular, I should never have praised it at all.

NASH. How! not descend to particulars! Why, you should have dwelt on all its beauties one by one.

HOOK. (*Aside.*) It would puzzle a body to detect half a one.—It is evident enough that you understand nothing of the present bang-up system of criticism, both in art and literature. Assert any thing—every thing—but explain nothing; extol or abuse, but never qualify praise with censure, nor dilute censure by commendation. Be dignified: never condescend to enter into any reasons for your violent liking or disliking. Besides being very un-oracle-like, to do so might be frequently exceedingly awkward. You comprehend!

NASH. I comprehend nothing, except that you have been a very bungling or lukewarm advocate, if not insincere also.

HOOK. Supposing me to have been the last, all the greater your obligation to me—all the more merit on my part in extolling as I did that precious pile and piece of work of yours, if I saw nothing to admire in it. And what did I get for my pains? Why, a rap over the knuckles from a fellow who dared not only to contradict me, but to quiz me into the bargain.

NASH. Architectural taste must then have fallen off most deplorably since the Augustan age of George IV. However, it is some comfort to reflect that far better judges than yourself, far more intelligent critics than the scribbling puppies you have left behind you, have expressed unqualified admiration of Buckingham Palace. It does not become me to vaunt of such honour, but the testimony in its favour of so distinguished a luminary of criticism as John Britton may well console me for the blindness and stupidity of all the rest of the world.

HOOK. Ay, that luminary, as you call him, certainly did once upon a time speak of Buckingham Palace as a structure of truly regal magnificence; but—

NASH. Don't torture me with *buts*: out with the worst.

HOOK. Why then, the worst is, that he thought fit afterwards, in his famous dedication to Queen Victoria, to tell Her Majesty she had no very great reason to be proud of Buckingham Palace. Do you feel consoled now?

NASH. A pitiful little humbug! After buttering me over, too, as he did, in a dedication addressed to myself.

HOOK. Oh, as to buttering, you are not the only one by many on whom Johnny has conferred *extreme unction*; but you now find that he can occasionally batter as well as butter. But, the truth is, that structure of yours had been so terribly carped at and sneered at, that your, and according to his own account, everybody's friend, John Britton, was fain to make a virtue of necessity, and save his own credit by joining in the general sneer.

NASH. But what necessity was there for his saying a syllable about either, one way or the other, on such an occasion.

HOOK. Surely you do not want to be told that the poor man's forte or foible, call it which you will, lies in giving vent to the grossest *bêtises* possible, and that he is everlastingly talking about himself in his prefaces, in the most rigmarolish manner possible. Did he not take it into his head, in one of them, to lecture the clergy? Did he not on one occasion make everybody stare by printing, in an advertisement, a letter addressed by him to the auctioneer whom he employed to sell some of his books, as if that functionary cared one farthing about his motives for disposing of them; though one of them was, that his old friends were dying off, and therefore he might as well get rid of his old books too!

NASH. That, then, accounts for it: the poor creature was out of his senses when he endeavoured to put the Queen out of conceit with Buckingham Palace. However, it was kind of you, very, to come forward afterwards and give me a good word.

HOOK. Kind! ay, and courteous, too, I assure you: therefore, I made it part of my generalship to stick to generals, leaving others to exercise their ingenuity in attempting to find out all the *whys* and *wherefores* of my panegyric,—criticism I eschewed.

NASH. For my part, I never chewed it, much less could I ever swallow or digest it. I had always a natural antipathy to criticism: it is as impertinent as looking at a *farded* complexion through a magnifying glass.

HOOK. Not bad that! But as to your own complexion, *alias* your reputation, it may once have been *farded*, but is now most confoundedly *faded*. However, never mind; John Britton, you know, tells us that posthumous reputation is all humbug, and, therefore, like a true philosopher as he is, he does not look to such an empty bubble! "Sour grapes!" You understand!*

NASH. But I had hoped—

HOOK. What? that a bubble would not burst? that a mere fashionable notoriety would never go out of fashion? Answer me sincerely,—Were ambition of fame and the love of art your *primum mobile*?

NASH. Let me tell you, Hook, you begin to be familiar and impertinent. I might as well ask you what pretensions you had to get youself dubbed a member of the Society of Antiquaries.

HOOK. And in welcome. In the first place, it is the fashion for every body that is any body, to stick a tail of two or three great letters to his name. It is all a piece of humbug; but the world likes humbug, and a more harmless sort can hardly be found. It is true I had never any great relish for antiquities, save and except old wine; but I had always a relish for antics, and for practical jokes; and I question whether I could have hit upon any other

* As regards posthumous fame, perhaps poor Theodore himself would have gone out of the world rather mortified, had he learnt that Wolff does not even so much as once mention him among the English novelists of the present day, although he notices many most decidedly his inferiors, to wit, the book-making Countess of Blessington, Lady Bulwer! and several others of the slip-slop school.

three letters in the alphabet equally significant, and equally applicable to my own case.

NASH. How so?

HOOK. Because, as I interpreted them to myself and my friends, F.S.A. stand for Fellow of Supreme Assurance.

NASH. So indeed they do; and they might be so interpreted in case of some other worthies who now strut about with those initials tacked to their names.

HOOK. Yes; men of letters on the strength of three letters of the alphabet.

LUCIANUS MINIMUS.

REVIEWS.

Gallery of Antiquities, Selected from the British Museum. By D. Arundale, Archt., J. Bonomi, Surv., and S. Birch. In monthly numbers. No. 1. Weale.

WORKS which profess to treat of antiquarian subjects, are either very expensive, or they are compiled by parties upon whom little dependence can be placed; so that the public are excluded from the one class, and apt to be misled, certainly not instructed, by the other. These circumstances are much to be regretted, because antiquarian research, made and followed up in a manner worthy of it, is a most instructive branch of knowledge, and neither the general condition nor the architectural remains of ancient nations, can be completely understood without it. In proportion, however, as it is important, it requires more caution on the part of the inquirer, as well as more preliminary knowledge.

The book of which a part now lies before us, does not fall under either of these descriptions. It is a book of knowledge; and, as far as we can judge from a single number, it is well adapted to its intended purpose.

Further than what appears in the number before us, we know nothing of Mr. Bonomi; but the names of the other two are a sufficient guarantee for his ability. From what we saw of the drawings of Mr. Arundale, and what we heard of his conversation soon after his arrival from the East, we are convinced that no man could do more justice to that part of the work which falls under his personal execution. He possesses great talents, among which accuracy holds a prominent part; and when he was abroad, his attention, especially to the remains of ancient Egyptian art, was most indefatigable; and we should safely say that, though others might make a more expensive work than the present, nobody could make one more faithful to the subject. Birch ranks high as an antiquarian critic. He is learned, without being pedantic, and scrutinizing without being fastidious; and therefore he is exactly the man to explode error and illustrate the truth. Of the second member of the triumvirate, we have already said that we know little; but the character of the others is security for him, and we shall be better acquainted in the course of the publication. The present number consists of Egyptian deities, copied from miniature statues, and illustrated by letter-press, every sentence, and in some places every phrase, of which, is substantiated by an appeal to one or another of those great men who have thrown so much light upon the very dark, but highly interesting, subject of Egypt in the ages which have long gone by.

Even while the most learned had little knowledge of the subject, and it was altogether as a sealed book to the majority even of learned and studious men, there was a disposition to look to Egypt as the birth-place of the sciences and the cradle of the arts, with regard to western learning especially, and in a great measure to that of the east.

There is too much similarity between the excavations of the banks of the Nile in Upper Egypt, and those of Elora, Elephanta, and other parts of south-western India, for allowing one to deny a common origin to the two. If those who constructed the works in Egypt had come from any other region—as, for example, from Syria, by Lower Egypt, the line of their march would have been marked by something resembling those excavations; and so also, had a people from anywhere in Asia excavated the rocks in the magnificent manner which exists there, they would have left corresponding memorials along the line of their march or their emigration: but we meet with nothing of the kind, either in the one place or the other. Remains of ancient art are indeed the monuments of the march of all civilized nations, over regions whose inhabitants are less civilized than they. But the traces of the ordinary migrations of such nations are found to consist of statues detached from the rock, and buildings formed by an accumulation of materials. The formation and finish of those statues varies through all degrees, from the meanest block, to symmetry of figure and exquisite finish; and so do the remains of buildings, even those of now nameless tribes, varying from marble walls, of which the different pieces are squared and joined in the nicest manner, to mounds and ramparts of earth, thrown together without symmetry, and almost without shape. But still, whatever may be the materials or style of workmanship, they all come under the class of buildings put together in parts, or of ornaments either wholly detached, or worked upon the substance of the buildings. Upper Egypt and south-western India are the only striking exceptions to this; and, as we said, there is enough of similarity in their general style, to make us impute them to some common origin.

Still, however, that community of taste, and probably of religious observance, which has given the rock excavations of Upper Egypt and south-western India that similarity of which we speak, must have taken place at a very early period, while both art, and superstition bearing the name of religion, were yet in their infancy. Both are so obscured in the mist of intervening ages, that we cannot obtain anything like a complete and clear view of either; but we have the same shadowy knowledge of the difference, as we have of the similarity.

To take a single point: there is a *triad*, or trinity, of the divine energy, in the mythology of each; both of them have many manifestations; and, in both, the subordinate gods are very numerous. The Indian triad consists of three male energies, the Creator, the Preserver, and the Destroyer. These, however, are not three gods, but only the manifestations of one god, who is divisible in manifestation, but not in essence, whose works are many, but whose nature is one. The Egyptian triad also consists of three manifestations; but they are a Father, a Mother, and a Son. Amoun, or Amoudon, is the Father in this triad, and he bears considerable relation to the Jupiter of the Greeks. Though the first manifestation in the triad, like Jupiter, he is not an immortal from the beginning. He is known by various names, according as his sup-

posed works vary; and one of them is Osiris, which is popularly considered as being the vivifying principal, of which the solar energy is not an inappropriate type. The meaning of his general name is "Glory," or "Exaltation," and his functions were understood to be, doing good to all who possessed his favour, bestowing prosperity in specific times, and giving success in war.

The second person, or manifestation, in this triad, is Maut, which stands for a female, and taken simply, means a mother. A vulture is the hieroglyphic for it; and to show that she is something more than a mere mother, a whip is added, as the emblem of authority. She is the wife of Amoun; and she possesses none of those horrible propensities which are imputed to the Indian goddess Khalee. Her attributes and propensities are much the same in kind as those of her husband, only they are inferior in degree. Her terrestrial manifestation is Night, and she represents the fertilisable energy. Thus the two leading manifestations of the Egyptian triad are the male and the female; but they are created or born, and not self-existent; not gods, but merely manifestations of that power of godhead of which all nature is the symbol.

Khous, or Chous, the son of Amoun and Maut, that is, the production of the solar energy and of night, or, in other words, of the fertilising power of the sun, and the fertilisable property of humid earth, is the third manifestation in the triad. His celestial symbol is the moon; and he is represented in various ways, according to the view which is taken of his powers—generally he is represented with a head like a hawk.

The number under consideration contains figures denoting these manifestations. In general, indeed we may say in every case, the statues of which representations are given are very small in size; but some of them are exquisite. They are in gold, in silver, in bronze, and in porcelain, and a few of them are in stone, altogether indicating an advanced state of the arts, equal, at least, in as far as the remains go, to that of China at the present day. Some are wholly, and some in part, gilded; but the gilding, or, rather, the plating with gold (for it is much more substantial than modern gilding), is fixed to the bronze by means of a cement, which proves that gilding, or plating, with one metal directly upon another, was unknown to the ancient Egyptians. These small statues do not appear to have been placed in temples as objects of public worship, but rather to have been household gods, kept in private dwellings; for it is among the ruins of cities, and not those of temples, that they have been found.

The British Museum is exceedingly rich in these remains, though, to the great body of the British people, they are merely sights to be seen, without conveying any information. The present work is well calculated for rendering them the means of information; and the specimen now published affords the best of all evidence as to the accuracy with which this will be done. It is true that the letter-press supplied by Mr. Birch, is only an index to the details; but it is a very correct index, and therefore more useful to beginners than if the subjects had been treated of at greater length.

Le Keux' Memorials of Cambridge: a Series of Views from Drawings by F. Mackenzie and J. A. Bell; with Historical and Descriptive Accounts, &c., by T. Wright, M.A., and Rev. H. Longueville Jones, M.A., &c. Parts I.—XXII.

We do not exactly know whether it is the letter-press or the engravings that lay claim to precedence in this work, yet presume it to be the former, because *two* editors are employed upon it, and therefore the office of one of them at least we should take to be a sinecure. Still we do not say that *two* would have been too many in a work of this nature, had the one undertaken the historical, and the other the descriptive part. It is this last, we are sorry to say, has fallen to the sinecurist's share; since what there is of architectural description is most unsatisfactory, while there is a very undue proportion of micrological information, both dry and tedious—yet no doubt considered important within the precincts of the respective colleges, though not at all calculated to recommend the work to the public generally. If, instead of plodding themselves, and making their readers plod, over the old beaten track, without starting anything fresh to enliven it, the editors had given merely a brief, but lucid, historical sketch of each college, &c., and entered into a full account of the respective buildings, both with critical remarks of their own, and others collected from various writers, they would have accomplished—that is, supposing them competent to the task—what is now a desideratum, by supplying us with an instructive and intelligent companion to Cambridge and its architecture. In fact, the title itself now promises as much, since it is the "Series of Views" which is there put foremost, while the "Historical Accounts" are mentioned as if entirely subsidiary to them. The editors will perhaps say that, nevertheless, the plates are intended merely as garnish to their labours. Even admitting such to be fact, we wish they had condescended to bestow more notice on the subjects of the plates, and described with some degree of care and accuracy the buildings represented in them, it being utterly impossible to understand an extensive edifice from a single perspective drawing of it, giving either a mere general view of it, or else a confined and partial one. If the work be intended only for Cambridge students and residents, or for those who visit the place, the excesssive meagreness of the descriptions may, in some degree, be excusable; yet hardly is the work intended to be confined to such class of purchasers;—some copies, for instance, may find their way to the continent, in which case, the chief information foreigners will be able to obtain relative to the buildings, will be that which is furnished by the views of them. It is only occasionally that even their general dimensions are stated. Great inconvenience and perplexity are also occasioned by the want of block plans, showing the different courts and groups of buildings of which the colleges consist. Such illustrations would have been very far more serviceable than the coats of arms and other bits of ornaments now given as wood-cuts. Even in regard to the plates themselves, this work manifests a falling-off from the companion one on Oxford; for the subjects drawn by Bell will bear no comparison whatever with those by Mackenzie; consequently there is a very marked inequality in that respect. We must further object, that even some of the views by the latter able draughtsman are merely repetitions of what he had previously made for other publications; and, no doubt, have been re-engraved from the very same drawings. This should not have been, and most certainly there was no occasion for it, as the subjects themselves admit of so much variety in the representation of them. In addition to the disappointment thus occasioned, it is no small one to find that of such a novel subject, and noble architectural acquisition to the University, as the Fitzwilliam Museum, no other illustration than a mere general view of the façade—and by no means the best executed plate of the kind—is here given; although three or four engravings might with very great propriety have been devoted to that interesting building. The

structure is, however, exceedingly well described, and its merits as a piece of architecture internally, as well as externally, are very intelligently pointed out and expatiated upon, whereas we meet with nothing of the kind elsewhere. Probably, therefore, this account was furnished by the architect himself. Whether such be the case or not, we would recommend the editors to adhere to that as their model for their architectural descriptions in future, especially those of the more recent buildings—such as Downing College, and the new public libraries.

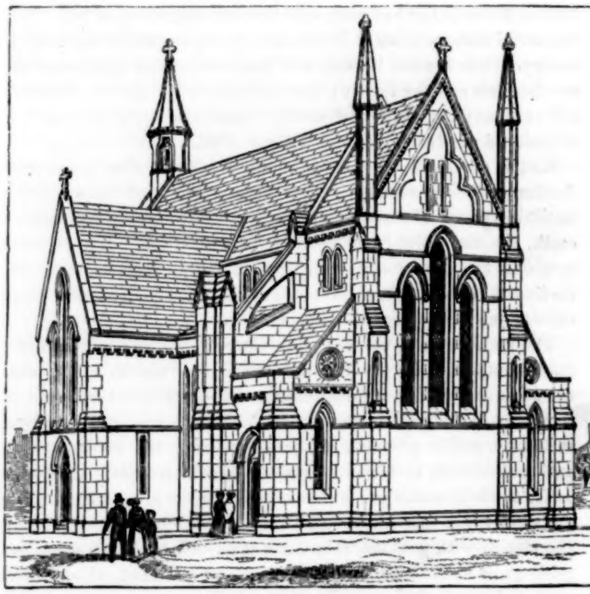
We should have been better pleased had we been able to speak of this work in more favourable terms; but it would seem that very little pains have been taken by any of the parties concerned in it; and we suspect that, after the very long stoppage in its publication, which took place at about the sixth number, it was resumed with no other view than that of completing, or rather, terminating it, with as little trouble as possible.

Companion to the Almanac.—New Buildings.

(SECOND NOTICE.)

SINCE writing our former article we have met with a sort of periodical, published by the Cambridge Camden Society, under the novel title of "The Ecclesiologist," relating chiefly to church architecture. The second number or sheet of that little work contains some remarks on the churches described in the "Companion," with an especial objection against the one at Streatham, as being in the Moorish style! and as "expressing only the spirit of a false religion." We should have thought those at all conversant with ecclesiastical architecture would have recognized the Lombardic character, which we presume may be received as sufficiently Christian, it being that ecclesiastical style which prevailed in Italy for many centuries, and which may in fact be termed the Italian Gothic. Perhaps, however, even that circumstance will not overcome the objection made against it, since it may then be urged that it expresses the spirit of a debased form of Christianity,—one which our national Church has repudiated. But what then becomes of our own Gothic? Do not our cathedrals, &c. all express most forcibly the spirit of Romanism,—that of a creed which we have abjured as idolatrous, and little better than a system of ecclesiastical tyranny on the one hand, and of vain superstitions on the other? Or what excuse, again, can be urged in favour of such forced imitations of *Pagan* architecture as the porticos of St. Martin's, St. Paul's, Covent Garden, and other things of the kind, which have not only escaped animadversion for their heathenism, but have been commended very far beyond their real architectural merits? We leave the Camden Society to ponder upon these questions, and to consider whether their scruples are not either very much overstrained, or else after all very lax.

While they—or at least the writer in "The Ecclesiologist" allows that Mr. Ferrey's church "has some commendable points," "there is," it is added, "an eastern triplet, [i. e. a triple window,] in which the arrangement of the string-courses strikes us as particularly objectionable, and the gable ornament is quite without authority." The last remark may be correct; and so far may be equivalent to merited condemnation in the opinion of those who consider "authority" of paramount importance in architectural design. What we chiefly find fault with is, that the two small windows are rather insignificant, and out of keeping with the rest. In speaking as we did of this church, we commended it not so much on account of its individual features, as for the pleasing combination which it presents upon the whole, and for its being, so far, in very much better taste than the generality of our Gothic churches, which, besides being excessively poor in detail, look positively naked and chilling, having nothing to disguise the nakedness, or break the monotony of their outline. How far Mr. Ferrey has succeeded in giving picturesque value to his small, unostentatious edifice, or how far the remarks in the Ecclesiologist evince the spirit of sound criticism, we leave our readers to judge from the woodcut of it in "The Companion," which we are enabled here to introduce.



Of course only the general forms are expressed in a sketch of this kind; therefore, allowance being made accordingly, we think the design will be found to justify the commendation bestowed upon it in "The Companion."

The most prominent subject of all is the intended building for St. George's Hall and the Assize Courts at Liverpool; but, as it requires more notice than we can now bestow upon it, we pass it by for the present, and turn to the Savings' Bank in Charlotte Street, Bath, just erected from the designs of Mr. G. Alexander.

This is a more than ordinarily tasteful specimen of Italian astylar composition; and although of very moderate dimensions, is free from that littleness of manner and insignificance of character, or else that poverty and nakedness, which manifest themselves in so many of our modern structures. We here observe a pleasing degree both of simplicity and richness: no part is left unfinished; but the whole is in due keeping, and properly filled up, without being at all confused or squeezed up, as is the case in the Atlas Office, Cheapside. There is also some originality of idea, for the rustic quoins are made of different lengths, those of each floor diminishing, owing to which circumstance, not only a pleasing degree of variety, but also the expression of greater strength in the lower part of the building, is produced. Another peculiarity in

the design is, that, instead of being in the same plane as the rest, the basement floor is made to project a little, so that the pedestals of the columns to the windows above it rest upon the string-course which crowns that lower division of the façade; whereby the character of solidity is there greatly increased. The building is entirely faced with stone, and may fairly be pronounced to be a considerable architectural acquisition to Bath, being very superior in taste to most of the structures which have obtained celebrity for that city.

INSTITUTION OF CIVIL ENGINEERS.

COMMUNICATIONS.

On the Improvement of the Roads, Rivers, and Drainage of the Counties of Great Britain. By Robert Sibley, *M. Inst. C. E.*

The author had on a former occasion drawn the attention of the Institution to the subject of a Bill before Parliament, "for the better regulation and general improvement of the Drainage of the Country;" and at the same time pointed out the course pursued by the magistrates of the County of Middlesex, in procuring with his professional assistance an accurate account of the Rivers, Bridges, &c., hoping that it might lead to similar surveys in other counties.

In the present communication he investigates the nature of the works which each county may be expected to undertake, and the means of accomplishing them economically, so that real public benefit may accrue.

The objects principally requiring the attention of the county magistrates he considers to be, First—Facility of intercourse by the improvement of the roads, bridges, rivers, and canals. Secondly—Protection from injury by the passage of the waters from or through the county; and Thirdly—The removal of causes tending to vitiate the atmosphere, or to render unwholesome the water used for the support of human life.

All these points, which do not appear to have been fully comprehended in the Sewage Acts, are examined at length, and suggestions are offered for their regulation, with examples of the effects resulting from their neglect.

The advantage of placing the water-courses of the country generally under a well-regulated system of manaagement, is insisted upon as the most effectual mode of guarding against the destruction of property, and not unfrequently of human life, which ensues from the effects of sudden inundations, such as have recently occurred in the county of Middlesex.

Description of the Great Aqueduct, Lisbon, over the Valley of Alcantra By Samuel Clegg, *Jun.*

This aqueduct was founded by king John the Fifth in 1713, and completed by the Marquis of Pombal, 1755. It resisted uninjured the shocks of the great earthquake in that year, although it was observed to oscillate considerably.

The most conspicuous part of the work is that which crosses the Valley of Alcantra; it consists of thirty-two arches, with spans varying from 50 to 105 feet; the crown of the centre arch is 225 feet from the ground. The length of this portion is 3000 feet.

The sources from which the supply of water is derived, are situated in the high ground in the neighbourhoods of Cintra and of Bellas—they are eighteen in number; one of these tributaries is conveyed by a culvert from a distance of fifteen miles.

The main duct into which the tributary streams empty themselves, forms a tunnel of 6 feet wide, and 7 feet high, ventilated by vertical shafts, at distances of a quarter of a mile apart.

The channels for the water are made with "drain tiles," 12 inches wide and 9 inches deep, open at the top.

After passing over the great aqueduct, the main duct runs under ground for half a mile, is carried across the "Estrada do arco Cavalho" on seven arches of 40 feet span each, on the south side of which it continues beneath the surface until it reaches the aqueduct of "Agua Livres" in Lisbon, and empties itself into the reservoir at its termination.

This reservoir is 60 feet long, by 54 feet wide and 27 feet deep. The quantity of water contained in it when the author took the measurements, was 64,800 cubic feet. He was unable to obtain a section of the retaining walls, but supposed them to be about 23 feet in thickness.

The pipes through which the water is distributed to the neighbouring fountains, are of earthenware and stone set in mortar. The velocity of its flow through the main duct is 75 feet per minute. The quantity discharged is about 73,000 gallons in twenty-four hours during the winter months.

The particulars relating to the construction of the aqueduct, the author translated from the documents preserved at the office of Public Works in Lisbon.

The foundations were laid in May 1713, and the piers, which, in common with the rest of the work, are of grey marble, carried up without footings. They are faced with ashlar work in courses from 1 foot 6 inches to 2 feet deep. The stones are dowelled together with bronze and iron; the centre portion of each pier is filled in with rubble masonry to within 30 feet of the top, above which it is left hollow.

The voussoirs of the principal arch, to which the author more particularly refers, are carefully jointed, their thickness being on an average 8 feet at the springing, and 5 feet on the square at the crown.

The figure of the arches is pointed Gothic, the rise being $\frac{7}{10}$ths of the span.

The spandrels are of closely jointed ashlar work, about 2 feet 6 inches in thickness.

The backings are filled in with rubble quite solid; nor is there any provision made for the drainage.

The mortar used was made with lime from the grey marble of the neighbourhood, and sharp *sea sand*, in the proportions of one of the former to four of the latter.

No mechanical contrivances were used for hoisting the blocks of marble, but they were slung upon poles from men's shoulders, and carried up a series of inclined planes to the height required.

Some of these blocks weighed upwards of three tons.

The scaffolding and inclined planes erected round the piers were of a very substantial description.

The lower parts were trussed framings formed of double Riga or Dantzic timbers 15 inches square, fastened together with trenails of teak and chestnut. The inclined planes had a rise of about 1 foot in 6 feet, with a level space at each end of the pier, to serve as a resting-place, where a separate gang of men received the stone block, and relieved the others.

The ends of the upright timbers of the scaffolding were not suffered to be surrounded by earth or moisture, but were placed upon blocks of stone, bedded firmly and evenly upon the rock, and kept well tarred. The struts and braces retaining them were also secured from decay in the same manner. These precautions were necessary, not only from the great weight they had to support, but from the length of time they remained in use—not less, it is supposed, than thirty years.

The centreing for the arches was constructed by an Italian architect, named Antonio Davila.

The arches were commenced from each side of the valley at the same time, and a temporary gangway erected over them as they proceeded, so

that the inconvenience of raising the material from the bed of the valley was avoided.

The centreings were framed in their places. The cradles which supported the bearing timbers of the lower truss, were morticed into sleepers resting upon projecting stones left for the purpose; those on the same pier were secured by cross timbers, so as to balance each other. The lower framings were first fixed and secured by straining pieces, and the upper portion erected afterwards in the manner of a roof principal. All the scarfs were cut vertically, fastened by trenails of teak, and but little iron was used in any part of the structure.

The striking wedges were placed under each voussoir, as in the French centreings.

As the arch rose from the springing, the crown of the centreing was loaded with stones to prevent it rising, and altering the shape of the arch.

The cost of the entire aqueduct, which was about 21 miles long, with all the immediate and collateral works, and including the reservoirs, was two millions and a half sterling.

The communication was accompanied by three elaborate drawings of the general construction and details of the aqueduct, with the manner of carrying the stones.

On Sea Defences constructed with Peat-Moss. By the Hon. MONTGOMERY STUART.

In the commencement of this communication, the author refers to the early period at which the art of reclaiming land from the sea was practised, and to the extensive districts both in Britain and on the continent, where sea defences of various kinds are constantly in course of construction. He then proceeds to detail the modes suggested by the experience of many years, and practised by him in constructing sea defences in the Bay of Wigtown, for the protection of the estate of his brother, the late Earl of Galloway.

The whole of the district abounded with peat-moss, possessing many properties which rendered it, independent of its cheapness, a peculiarly valuable material for constructing embankments to resist the action of the sea. Its tough fibrous nature, its elasticity, and at the same time the rapidity with which the mass became solid, were useful qualities which he sought to take advantage of. He found, also, that it possessed advantages as a material for puddling; as, from its absorbent nature, it imbibed and retained all the moisture that approached it, and never cracked from dryness, as occurs so frequently with clay puddle. In case, also, of holes being made in the puddle, either by vermin or external injury, they soon closed again from the elastic nature of the peat-moss, and its tendency to grow together.

The author sometimes uses peat-moss as a puddle between two ranges of stone walls, and sometimes as a backing instead of clay-sod; but he more particularly recommends it as a backing to a stone defence parallel with the shore. For this purpose, the turf should be cut thin, placed against the bank, and the stone-work built against it; he has found this the most durable and effectual defence against the sea; the action of the waves against it even adding to its security, as from its fibrous nature it retains the silt thrown against the wall until all the interstices between the stones are completely filled, and a defence is thus formed for the wall itself, by the accumulation against it.

The method he employs is to build the sea-wall of rough rubble stone, laid dry, with a slope of about two to one; the peat-moss backing, cut into blocks, rather thicker than usual, is laid in courses, well bonded and beaten together; it is thus consolidated throughout the height of the wall. Upwards of twenty years have elapsed since some of the first embankments were made on this principle; they have perfectly answered the purpose, and have been the means of effectually reclaiming a great extent of valuable land.

The author also states, that he has lately been occupied in forming a defence, by warping silt, with whin or gorse kids, laid horizontally; a method which he prefers to that practised in Lincolnshire, where the kids are placed upright. He keeps the kids in their positions by means of stones laid on them, which are removed as the surface rises; fresh kids are then added, and the stones relaid.

The communication is accompanied by three sections of the sea defences, as they are executed, and by some corroborative testimony as to their efficiency, by Mr. Lewin, of Boston, who has examined and reported upon them.

Full instructions are also given for constructing the different kinds of defences mentioned.

NEW ROYAL EXCHANGE.

ON Monday, the 17th instant, took place the ceremony of laying the first stone of the new Royal Exchange by his Royal Highness Prince Albert. The pavilion prepared for it was erected by W. Tite, Esq., F.R.S., the distinguished architect of the building; and certainly nothing could be more light, elegant, and imposing, than its effect. It was upwards of 80 feet high, and 300 feet in circumference. Around the amphitheatre were 11 tiers of seats rising gradually to the height of 24 feet. The seats, as well as the floor of the tent, were covered with crimson drapery, the reserved seats in front being festooned with the same, and at the back a tastefully designed festoon of crimson and white drapery, confined at certain distances by rosettes, went round the entire walls of the tent. The floor, or platform, on which the stone was placed, was forty feet in diameter, and there were two chairs of state placed in front of the stone, for the accommodation of his Royal Highness Prince Albert and the Lord Mayor. Over the entrance to the tent was an orchestra for the band, the front of which was decorated with drapery, on which the royal and city arms, the arms of the various city companies, and of Sir Thomas Gresham, were emblazoned. On a pedestal on either side of the entrance was placed a very beautiful model of the intended building; one of them representing its western front, and the other the merchants' quadrangle. The tent was lighted by a circular chandelier, containing about fifty gas-lights, and when the entire amphitheatre was filled, the whole presented a spectacle of great animation and brilliancy. The general expense incurred in the erection of the amphitheatre, and other preparatory matters, is estimated at £1,000.

The stone, which is of granite, and several tons weight, was divided into two compartments, the one portion being fixed in its proper position, and the other suspended over it at a height of about two feet by strong ropes and pullies, and further supported by four upright pieces of timber.

The company was very numerous. Her Majesty's Ministers, the Lord Mayor and Aldermen, the Chairman and other members of the Gresham Committee, &c. &c., were among them. On Prince Albert's entry, he took his station by the side of the stone, where he was attended by four members of the committee, bearing the glass bottle for the coin, a glass brick with an English inscription incrusted thereon, the mallet, and the level.

The Chairman of the Joint Gresham Committee, bearing the trowel, then took his station on the side of the stone, opposite his Royal Highness. The architect after him took his station on another side of the stone, and exhibited the models of the New Exchange. The clerk of the committee took his place opposite the architect, with the plate on which the inscription was engraved. The member of the committee, bearing the glass bottle, then held it to Prince Albert, who placed therein the coin which he received from Sir James Shaw, Bart., Chamberlain of London, and Joseph Thomas Pooley, Esq., master of the Mercers' Company.

His Royal Highness having deposited the same in the well of the stone, the member of the committee bearing the English inscription incrusted on glass then presented the same to his Royal Highness, which, being read by Mr. James Barnes, the clerk of the committee, his Royal Highness also deposited in the well.

The architect (Mr. Tite) then read the inscription on the stone, in Latin and English, in a distinct and scholar-like manner, which gave full effect to the composition. The following is the translation of the Latin inscription.

Sir Thomas Gresham, Knight,
Erected at his own charge,
A Building and Colonnade,
For the convenience of those Persons
Who in this Renowned Mart
Might carry on the Commerce of the World,
Adding thereto, for the Relief of
Indigence
And for the Advancement of Literature
And Science,
An Almshouse and a College of Lecturers,
The City of London aiding him,
Queen Elizabeth favouring the Design,
And when the Work was complete,
Opening it in Person with a solemn
Procession.
Having been reduced to Ashes,
Together with almost the entire City,
By a calamitous and widely-spreading
Conflagration;
They were re-built in a more splendid form
By the City of London
And the ancient Company of Mercers,
King Charles the Second commencing the
Building
On the 23d October, A.D. 1667;

And when they had been again destroyed
By Fire,
On the 10th January, A.D. 1838,
The same Bodies, undertaking the Work,
Determined to restore them at their own Cost,
On an enlarged and more ornamental plan,
The munificence of Parliament providing the
Means of extending the site,
And of widening the approaches and crooked
Streets in every direction,
In order that there might at length arise,
Under the auspices of Queen Victoria,
Built a third time from the ground,
An Exchange
Worthy of this great Nation and City,
And suited to the vastness of a commerce
Extended to the circumference
Of the habitable globe.
His Royal Highness
Prince Albert of Saxe-Coburg and Gotha,
Consort of her sacred Majesty,
Laid the first stone
On the 17th January, 1842,
In the Mayoralty of the Right Hon. John Pirie.
Architect, William Tite, F.R.S.
May God our Preserver
Ward off destruction
From this Building
And from the whole City.

After a short address from Mr. Lambert Jones, his Royal Highness then took the trowel, and spread the mortar over the stone. The stone was then lowered to its place, under the direction of Mr. Thomas Jackson, the contractor; when the members of the committee bearing the level and mallet presented them to his Royal Highness, to adjust and set the stone. The City state sword and mace were then placed crossways upon the stone, after which the Rev. Henry Thomas, A.M., chaplain to the Lord Mayor, offered up an appropriate prayer, and the children belonging to the charity school of the ward of Broad-street sang the national anthem.

His Royal Highness then took his departure amid the loudest cheers, the procession forming in the same order in which it entered.

MISCELLANEOUS.

Institution of Civil Engineers.—The annual general meeting of this society was held on Tuesday evening, the 18th, when silver Telford medals were presented to Messrs. Bateman, Seaward, Green, Sopwith, and Schafhaeutl; and Telford and Walker premiums of books to Messrs. Bateman, Stevenson, Dobson, Mallet, Colthurst, Page, and Birch, for papers of merit read at the meeting during the past session. The report of the council upon the proceedings of the past year and the finances of the Institution was read. It would appear that its sphere of usefulness is extending, as might naturally be expected, in this country, where its value can be best estimated. The following members of council were elected:—J. Walker, president; W. Cubitt, B. Donkin, J. Field, H. R. Palmer, vice-presidents; G. Lowe, J. M'Neill, J. M. Rendell, S. Seaward, R. Sibley, J. Simpson, T. Wicksteed, W. T. Clark, G. Rennie, J. Taylor, F. Braithwaite, and W. Cubitt, other members and associates of council. The president addressed the meeting, and, in some judicious remarks, directed more especially to those who aspired to join the profession, recommended more application to the practical parts of engineering, in order to the more correct use of theory. He instanced the recent engineering appointments to the colonies; and certainly in foreign countries, where artisans must be created, the engineer is called on to possess more practical knowledge than in this country, where intelligent contractors save him much of the details of the work. Here the master mind conceives an idea, and ready instruments are found to carry it out, but there the same mind must originate the plan and give the details of execution. He alluded to the professorships of engineering in the different universities, from which it appears that only that of Glasgow is in the appointment of the Government, and it pleased us much to hear that the Rt. hon. baronet now at the head of the Government had expressed himself favourably of the objects of the institution and the progress it had made under the present direction. After the election of officers, Mr. Dent, of the Strand, explained the movement of his astronomical clocks with dead-beat scapement, and with the improvement of giving the impulse to the pendulum at, or as nearly as can be determined, the centre of percussion: by this arrangement the irregularities occasioned by friction and other disturbing causes are avoided, and many advantages are obtained. The president announced that the papers to be read at the next meeting on Tuesday, February the 1st, would be "A Memoir of Captain Huddart," by Mr. W. Cotton; "A Description of the Works of the London Docks," by Mr. R. Richardson; and "A Description of the Bridge over the River Serchio, at the Bagni Caldi de Lucca," by Mr. R. Townshend.

The Croydon Slip.—Considerable progress has been made in removing the earth which had fallen on the line, though quantities of it occasionally slip down. A boarded platform, surmounted by semicircular awning, to the extent of 260 feet, has been constructed on the east side of the line for the accommodation of the passengers, and is in every respect ample and commodious. The day and night gang of workmen employed is about 1,500, so that the line presents quite an animated appearance. The rails are now clear to about the extent of 100 feet, and it is expected they will be completely cleared in about a month. Two steam-engines and eight horses are constantly at work, and the temporary bridge intended to be used in conveying the earth over the old spoil bank is nearly completed. The slip is gradually following up at the foot, which will be the case until the top of the slip is removed, so as to get rid of the superincumbent pressure on the foot.

College for Civil Engineers.—It is reported that Dr. Charles of Putney is to succeed Dr. Johnstone, the late Resident Medical Officer, at a much lower salary than the latter received.

Royal Geographical Society.—A very full meeting was held on Monday evening, the 24th, amongst the company being the Bishop of Norwich, Sir R. H. Inglis, and several other distinguished members. Amongst the presents, were 22 charts of the coast of France, and several other maps from the Depôt de la Marine, at Paris, and the communications read were of a very interesting character. The first was the result of a new chain of observations made to determine the depression of the Dead Sea, by Lieutenant Symons, in which he proved that this was at least 1,400 feet below the Mediterranean. A letter was read from Captain Simons, dated Auckland, New Zealand, Oct. 4, 1841. He had traced the sources of several rivers on the north-east part of that island, where he found the natives very different to what they had been described to him at home. In their behaviour, they were fickle and captious, and rob only in anger, but will not attack Europeans. He also described the chain of hot springs running across the north-east part of the island. A paper from Sir James Alexander gave an account of the sandy plains to the west of the Rocky Mountains in North America, where he had been engaged in fixing the boundary line between this country and the United States. He described having heard of a tribe of Indians of fair complexion, who possessed a superior knowledge of the arts, and spoke a language of their own. These were supposed to be the remnants of the Welch colony, who, if they existed anywhere, would probably be found about the 42nd parallel of latitude. In the August of last year, Mr. Evans, a Welch gentleman, from New York, had set out to go to Santa Fé, whence he would start with the first caravan across the Rocky Mountains, in order to endeavour to find this lost race of his countrymen, who left Wales under Prince Madoch, in 1169. An interesting communication was next read from the Rev. Mr. Yetta, on three singular nomadic tribes, inhabiting Asia Minor.

Composition of the Atmosphere.—Experiments have lately been made simultaneously at Paris, Berne, and Faulhorn, for the purpose of ascertaining whether the proportions of oxygen and nitrogen were the same at all these places. The main result is, that, out of 10,000 parts of air at Paris, there were 2,304 parts of oxygen; at Faulhorn 2,297, and at Berne 2,295. As the proportions at one of these places are found to differ much more than the mean of the three places differs, the conclusion is, that the constitution of the air is the same at all places, and of course it must be a chemical compound.

LIST OF PATENTS.

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(SIX MONTHS FOR ENROLMENT.)

William Church, of Birmingham, civil engineer, and Jonathan Harlow, of the same place, manufacturer, for "certain improvements in the mode of manufacturing metallic tubes, and in the mode of joining them, or other tubes or pieces for various useful purposes."—Sealed December 16.

Thomas Starkey, of Birmingham, copper-cap manufacturer, for "improvements in percussion caps for discharging fire arms."—Sealed Dec. 16.

John Americus Fanshawe, of Hatfield Street, Surrey, gent., for "an improved manufacture of water-proof fabric, applicable to the purposes of covering and packing bodies, buildings, and goods exposed to water and damp."—Sealed December 16.

William Buckwell, of Trinity Street, Borough, civil engineer, for

"improvements in scaffolding or frame-work for building purposes."—Sealed December 16.

Charles Loosey, of Half-moon Street, Piccadilly, civil engineer, for "improvements in steam engines, and which improvements are also applicable in raising or forcing water and propelling vessels."—Sealed December 16.

John Bould, of Ovenden, Halifax, cotton spinner, for "an improvement or improvements in condensing steam engines."—Sealed December 16.

Antoine Jean Francois Claudet, of High Holborn, glass merchant, for "certain improvements in the process or means of, and apparatus for, obtaining images or representations of nature or art."—Sealed Decemb. 18.

Henry Hough Watson, of Bolton le Moors, Lancaster, consulting chemist, for "certain improvements in dressing, stiffening, and finishing cotton and other fibrous substances, and textile and other fabrics, part or parts of which improvements are applicable to the manufacture of paper, and also to some of the processes or operations connected with printing calicoes and other goods."—Sealed December 21.

William Edward Newton, of Chancery Lane, civil engineer, for "certain improvements in lamps and burners, and in the means of supplying air and heat thereto for the support of combustion," being a communication. —Sealed December 21.

William Newton, of Chancery Lane, civil engineer, for "certain improvements in cleansing wool, and facilitating the operation of dyeing, and also in washing and bleaching cotton yarns or fabrics," being a communication.—Sealed December 21.

Ovid Topham, of Whitecross Street, Strand, engineer, for "improvements in engines, machines, apparatus, or means for extinguishing or stopping the progress of fire in any room or part of different buildings which may have become ignited, such as noblemen or gentlemen's mansions, houses, factories, store and warehouses, and consequently preserving them from destruction, and preventing the loss of life."—Sealed December 21.

George Palmer Henry, of Peckham, chemist, for improvements in apparatus to be applied to the glass chimneys of gas burners."—Sealed December 21.

John Cox, of Gongie Mills, Edinburgh, tanner and glue maker, for "certain improved processes of tanning."—Sealed December 21.

John Oliver York, of Upper Coleshill Street, Eaton Square, engineer, for "improvements in the construction of railway axles and wheels."—Sealed December 21.

William Carron, of Birmingham, lathe maker, for "improvements in the construction of clogs and pattens."—Sealed December 21.

William Henry Smith, of Finsbury Chambers, London, civil engineer, for "improvements in the construction and manufacture of connectors or fastenings applicable to garments and other uses."—Sealed December 21.

Adolphe Fourment, of Museum Street, engineer, for "improvements in castors for cabinet furniture and other purposes."—Sealed December 21.

Thomas Wright, of Church Lane, Chelsea, lieutenant in the Royal Navy, and Alexander Bain, of Percival Street, Clerkenwell, mechanist, for "improvements in applying electricity to control railway engines and carriages, to mark time, to give signals, and print intelligence at distant places."—Sealed December 21.

Henry Alphonse Bonnevialle Bouveiron, of Trevor Square, merchant, for "improvements in axle-trees," being a communication.—Sealed December 21.

William Burge, of Bristol, sign painter, for "improvements in propelling vessels."—Sealed December 21.

William Carr Thornton, of Clockheaton Coy, of York, machine maker, for "certain improvements in machinery or apparatus for making cards for carding cotton and other fibrous substances."—Sealed December 21.

John Watson, of Chorly, Lancaster, gent., for "improvements in the construction of filters used in the manufacture of sugar."—Sealed Dec. 23.

William Baillien, of Gloucester Street, Queen's Square, Bloomsbury, musician, for "improvements in apparatus to expand the human chest."—Sealed December 23.

William Robinson Kettle, of Waterloo Street, Birmingham, accountant; Benjamin Wakefield, of Ryeland Street, Birmingham, civil engineer, and William Crosher, of Cumberland Street, Birmingham, screw manufacturer, for "an improved bolt for building and other purposes."—Sealed December 24.

Montagu Macdonogh, of St. Albans Place, Middlesex, gent., for "improvements in spindles, flyers, and bobbins, for spinning, twisting, and reeling all sorts of fibrous or textile substances, and in the application or adaptation of either or all of them to machinery for the same purposes," being a communication.—Sealed January 6.

Edward Hall, of Dartford, civil engineer, for "an improved steam boiler."—Sealed January 11.

Samuel Hearne Le Petit, of Saint Pancras Place, Saint Pancras Road, for "certain improvements in the manufacture and supply of gas," being a communication.—Sealed January 11.

James Chesterman, of Sheffield, mechanist, and John Bolton, of the same place, mechanist, for "certain improvements in tapes for measuring, and in the boxes for containing the same."—Sealed January 11.

Charles Wye Williams, of Liverpool, gent., for "certain improvements in the construction of furnaces, and effecting combustion of the inflammable gases from coal."—Sealed January 11.

John Tresahar Jeffree, of Blackwall, engineer, for "certain improvements in lifting and forcing water and other fluids, parts of which improvements are applicable to steam engines."—Sealed January 11.

Richard Dover Chatterton, of Derby, gent., for "certain improvements in propelling."—Sealed January 11.

James Tons, of Newcastle-upon-Tyne, gent., for "improvements in smelting copper ores."—Sealed January 13.

Julins Bordeir, of Austin Friars, merchant, for "certain improvements in preparing skins and hides, and in converting them into leather."—Sealed January 13.

Caleb Bedells, of Leicester, manufacturer, and Joseph Bedells, of the same place, manufacturer, for "improvements in the manufacture of elastic fabrics and articles of elastic fabrics."—Sealed January 13.

Joseph Barnes, of Church near Accrington, Lancashire, manufacturing chemist, for "certain improvements in the working of steam engines." —Sealed January 13.

Henry Waterton, of Winford Lodge, Chester, esq. for "improvements in the manufacture of salt."—Sealed January 13.

John Jeremiah Rubery, of Birmingham, umbrella and parasol furniture manufacturer, for "improvements in the manufacture of a certain part of umbrella and parasol furniture"—Sealed January 13.

Moses Poole, of Lincoln's-Inn, gent., for "improvements in the construction of locks," being a communication.—January 15.

John Thackeray, of Nottingham, lace thread manufacturer, for "improvements in the process of preparing and gassing thread or yarn."—Sealed January 15.

Thomas Lambert, of Regent's Park, musical instrument maker, for "improvements in the action of cabinet pianofortes."—Sealed January 15.

Edward Palmer, of Newgate Street, philosophical instrument maker, for "improvements in producing printing and embossing surfaces."—Sealed January 15.

James Cole, of Youl's Place, Old Kent Road, brush manufacturer, for "certain improvements in the construction of brushes."—Sealed January 15.

Cornelius Ward, of Great Tichfield Street, musical instrument maker, for "improvements in flutes.—Sealed January 18.

William Trisdall, of Cornhill, ship owner, for "a new and improved method of extracting or manufacturing from a certain vegetable substance certain materials applicable to the purposes of affording light and other uses."—Sealed January 19.

Antoine Mertens, of the London Coffee House, publisher, for "improvements in covering surfaces with wood, being a communication,"—Sealed January 22.

William Baker, of Grosvenor Street, Grosvenor Square, surgeon, for "certain improvements in the manufacture of boots and shoes."—Sealed January 27.

John James Baggaly, of Sheffield, lead engraver, for "certain improvements in making metallic dies and plates for stamping, pressing, or embossing."—Sealed January 27.

Andrew Kintz, of Liverpool, chemist, for "certain improvements in the manufacture of artificial fuel."—Sealed January 27.

Francis Marston, of Aston, Salop, esq., for "improvements in apparatus for making calculations."—Sealed January 27.

Samuel Mason, of Northampton, merchant, for "improvements in clogs, part of which improvement is applicable to shoes and boots."—Sealed January 27.

Gottlieb Boccins, of the New Road, Shepherd's Bush, gentleman, for "certain improvements in gas, and on the methods in use, or burners for the combustion of gas."—Sealed January 27.

William and John Galloway and Joseph Haley, of Manchester, engineers, for "certain improvements in machinery for cutting, punching, and compressing metals."—Sealed January 27.

Pierre Journet, of Dean Street, Soho, engineer, for "improvements in steam-engines."—Sealed January 27.

Henry Benjamin, of St. Mary-at-Hill, fish factor, and Henry Grafton, of Chancery Lane, philosophical instrument maker and machinist, for "improvements in preserving animal and vegetable substances."—Sealed January 27.